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Blueprint for Sectoral Cooperation on Skills: Towards an EU Strategy Addressing the Skills Needs of the Steel Sector

May 2020

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BLUEPRINT FOR SECTORAL COOPERATION ON SKILLS: TOWARDS AN EU STRATEGY ADDRESSING THE SKILLS NEEDS OF THE STEEL SECTOR

European vision on steel-related skills and supporting actions to solve the skills gap today and tomorrow in Europe

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COSME

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ABSTRACT

The study "European vision on steel-related skills and supporting actions to solve the skills gap today and tomorrow in Europe" was initiated to pursue the key priority actions identified by the European Commission in the framework of the Blueprint for Sectoral Cooperation in the steel sector. These included acquiring comprehensive knowledge on the current situation of the steel workforce with regards to skills availability and shortages as well as providing a state-of-play description of the different national education and training systems in seven target countries: Finland, France, Germany, Italy, the Netherlands, Poland and Spain. Information on these two aspects was gathered by engaging with key sector stakeholders, including industry representatives, trade unions, education providers, and public authorities. Additionally, the study provides insight into jobseekers' perceptions of careers in the steel industry, suggesting which biases and challenges may affect their choice to take up such a career. Based on the research findings, the study proposes a series of recommendations on actions that can support skills development in the steel sector and increase the attractiveness of the steel industry among talented jobseekers. The study is complemented by two implementation roadmaps for bridging the skills gap in the European steel industry.

EXECUTIVE SUMMARY

The study "European vision on steel-related skills and supporting actions to solve the skills gap today and tomorrow in Europe" was carried out to provide a state-of-play analysis of skills supply and demand in steelmaking companies and develop concrete actions that can be implemented to meet the skills needs in the European steel sector. The study investigated perceptions and causes of current and future skills needs and compared the skills needs of the industry with the educational offering, both in higher and vocational education. In addition, the study explored existing practices for upskilling and reskilling the workforce in the steel sector, including on-the-job training programmes. Lastly, it also shed light on the image of the steel sector and careers within it, identifying the main drivers and barriers that may affect the choice to take up a career in the steel sector. The study focused on the production of steel, considering the competencies needed by workers employed in areas such as melting shops, finishing areas, rolling mills, maintenance and expeditions, quality control, health and safety, and R&D. The present report provides an overview of findings at European level (EU-28), some examples of best practices for skills development in the steel sector, seven national profiles with country-specific findings for Finland, France, Germany, Italy, the Netherlands, Poland, and Spain as well as two implementation roadmaps to address skills gaps and needs in the European steel industry.

Context

Coal and steel were the strategic industries upon which the European project was initiated. Even today, with about 500 production sites active in 24 Member States, the steelmaking industry represents an important asset for the European economy. Having a yearly output of about 160 million tonnes of crude steel and a yearly turnover of EUR 170 billion, Europe is currently the highest steel importer and the second largest steel producer worldwide after China. European steel contributes to a series of downstream industries, notably automotive, construction and infrastructure, robotics, advanced machinery and tooling, and home appliances. It provides over 320,000 direct jobs and 1.5 million indirect jobs.

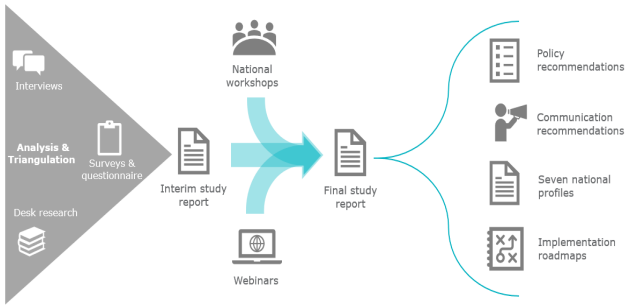
However, the 2008 economic and financial crises severely destabilised the industry, which suffered a drastic decrease in demand from its two core customer sectors, i.e. automotive and construction. Crude steel production fell by over 34% and 40,000 jobs were lost between 2009 and 2013. In addition, the European industry also faces increasing competition from emerging economies flooding the market with cheap steel, while simultaneously increasing the price of raw materials. International competition is exacerbated by the difficulty of creating a level-playing field, as some countries adopt discriminatory and imbalanced practices. These include trade restrictions in the form of tariffs and non-tariff measures, dumping and predatory commercial behaviour. These challenges have severely impacted the European labour situation as evidenced by site closures, mergers and restructuring leading to a significant contraction of the workforce. This, in turn, weakened the image of the steel sector as a reliable employer. Finally, the COVID-19 pandemic also caused major disruption to the sector during 2020, the implications of which are yet to be fully understood.

To support the European steel industry, the European Commission has put in place several measures over the years, including defence measures to prevent unfair imports of subsidised steel products. It has also welcomed the launch of a Global Forum on Steel Excess Capacity in 2017, and most importantly, developed the "Action Plan for a competitive and sustainable steel industry in Europe" in 2013. The plan outlines a series of measures and recommendations to ensure the competitiveness of European steel and sets a clear direction for the future of the industry. Rather than competing on cheap price and low social standards with non-EU producers, the European steel industry should become a benchmark of innovation and product quality and contribute to the achievement of the EU targets for an innovative and sustainable industry.

As highlighted in the communication "Steel: Preserving sustainable jobs and growth in Europe", a production model oriented towards innovation and sustainability calls for a highly qualified workforce. To support this priority, steelmaking has become part of the policy programme "New Skills Agenda for Europe", and more specifically of the "Blueprint for Sectoral Cooperation on skills". These programmes aim to understand how skills needs and steel careers will evolve in the near future and devise effective strategies to ensure the competitiveness of employees. This study was launched as part of the "Blueprint for Sectoral Cooperation on Skills" in the steel sector to support a larger analytical framework and encourage informed actions to help the industry acquire workers with the right skills and improve the overall attractiveness of steelmaking as a possible career choice.

Methodology

To achieve the objectives of the study, an integrated research approach was adopted, including qualitative and quantitative (statistical) data collection methods.



A first basis of secondary data provided by literature review and the content analysis of online job advertisements was complemented by semi-structured interviews with key sectoral stakeholders (industry and trade union representatives, education providers at all levels and policy makers), an explorative questionnaire, and two multi-component surveys.

The questionnaire aimed to gather detailed information about specific initiatives for up-/reskilling in the steel sector. The final sample gathered 16 respondents. This small sample size is explained by the limited number of initiatives currently existing that simultaneously target skills development and the steel sector, since measures and policies for skills development tend to have a cross-sectoral scope. This was also confirmed by both desk research and expert statements.

Survey 1 targeted professionals from the industry, with a view to investigate current and future skills needs from the perspective of the steel professionals in charge of selecting and training the personnel. It also investigated factors causing skills gaps and possible measures to address them. There were 197 respondents and data collected was analysed via basic and advanced analytics, including MaxDiff.

Survey 2 addressed students, graduates and jobseekers with a STEM-related background. They exploited advanced techniques (MaxDiff, Choice-Based Conjoint i.e. CBC analysis) to explore perceptions and attitudes towards the steel sector as a possible career choice. The total sample was of 2,002 respondents.

Triangulation was used to combine data from the different research methods. Based on the findings from triangulation, preliminary conclusions and recommendations were developed and presented in the study "European vision on steel-related skills of today and Tomorrow" (published in August 2019). In order to validate these and to gather more inputs on the target countries (Finland, France, Germany, Italy, the Netherlands, Poland and Spain), seven national workshops were organised, bringing together key stakeholders from national steel industries as well as education providers and representatives of workers' associations. Building on the outcomes of the workshops, two implementation roadmaps were developed, notably "Building the necessary skills for the EU steel industry" and "Towards EU Education and Training on steel industrial technology skills".

Two international online webinars were carried out to validate the recommendations of the study and the related implementation roadmaps, moving from the national level to the European level.

The work culminated in the present study report, which includes findings on skills needs in the European steel industry, examples of best practices in up-/reskilling the workforce or improving the image of the steel sector, national profiles of the seven target countries as well as two implementation roadmaps focusing on the next five years.

Recommendations

Policy recommendations

Monitor and anticipate steel industry skills needs – Setting up common European tools for skills needs monitoring and anticipation, for instance a centralised EU observatory for the steel industry, would help businesses in the sector, education and employment services providers as well as the EU and national policy makers to rapidly and effectively adjust their up-/re-skilling and recruiting processes. This will minimise the time lags between the introduction of an innovation and the provision of suitable training, an aspect that was found to be at the origin of skills gaps in the steel sector.

Provide and promote training in transferable skills – In the context of constant and rapid changes in the job market, companies' needs seem to move towards T-shaped (i.e. technical and transversal) skillsets. Hence, sectoral organisations at EU-level could cooperate to design programmes aimed at building transversal competencies in the steel sector, while companies could leverage existing resources within and outside the steel sector (e.g. steeluniversity's e-learning offer) to help metalworkers acquire competences that facilitate their adaptation to new requirements, technologies and modes of working.

Expand and promote on-the-job forms of training – Workers of the future will have to engage in lifelong learning and on-the-job forms of training represent some of the most effective methods for the provision of knowledge and skills requirements. Internships offered to students by the steel industry are also regarded as a good educational opportunity with the additional potential to help attract underrepresented groups. While numerous companies (and trade unions) already run such internship and training programmes, there is room for improvement in terms of sharing examples of good practice, jointly developing training resources and encouraging companies and workers to take ownership of their own learning needs.

Promote (reverse) mentorship as a way of knowledge transfer between older and younger workers – Large amounts of workers being on the brink of retirement is one of the urgent challenges the steel industry is facing. Mentorship appears to be a particularly viable method of ensuring that valuable knowledge is not lost in the process and is appropriately transferred to younger generations of workers. On the other hand, young people bring in valuable skills in their own right that they can share with their more senior colleagues, particularly in terms of digital skills. Solidifying and further expanding mentorship programmes, whenever possible in the form of reverse mentoring, therefore must be a crucial part of any forward-looking education and training strategy.

Encourage exchanges between public authorities, education providers and steel companies to promote digital and advanced technology skills, dual education and lifelong learning – Increased cooperation between companies, education providers and local governments would help build a common approach to addressing the skills needs stemming from megatrends like digitalisation and green transition. Together, they can implement effective educational responses such as dual education schemes, apprenticeships and strategic public-private alliances, as well as promote lifelong learning systematically, continuously and widely.

Promote social dialogue to ensure that as many workers as possible are included in skills development strategies – New trends such as Industry 4.0 and the green transition come with a risk of exclusion, especially for medium- and low-skilled profiles. To ensure that no one is left behind, structured interventions should be sought at company and trade union levels. Measures to support and guide workers at all levels in the digital and green transition should be developed, building on a strong policy action both at EU and national level.

Include underrepresented groups, such as women and migrants – Against the backdrop of an increasing shortage in skilled labour, women and migrants represent two large groups that remain majorly untapped by the steel industry. Putting in place measures to attract and integrate these underrepresented groups would help the European steel industry address its skills gaps and remain competitive in the future.

Communication recommendations

Emphasise the prominence of steel in every aspect of modern society - Steel is present in nearly all aspects of our lives. Companies are carrying out cutting-edge research to meet the EU's targets on climate change, and trends such as Industry 4.0 create new and stimulating challenges for anyone interested in ICT and technological research. However, according to stakeholders in the industry, the general public seems to be largely oblivious of this and underestimates the importance of steel in modern life, whilst skilled young people seem unaware of the dynamism of the industry.

Increase visibility to high-skilled positions that do not require physical strength and highlight task variety – Steel careers are still perceived as manual and physically demanding. The development of automated processes, however, has already impacted steel production chains, reducing manual labour and physical stress. A larger variety of positions that do not require physical strength should be promoted more widely. Language can play a role in changing the perception of steel careers, especially if the industry is looking to recruit from beyond its traditional talent pools; for instance shifting from the traditional word "worker" to "employee" can help revert negative associations with physically demanding work. Additional factors can be leveraged to attract talented professionals to work in the steel sector. According to the results of the CBC analysis, students, graduates and jobseekers attribute great importance to positions that combine sedentary work with physical work. Moreover, the linear regression model that explains variance in the willingness to work in the steel sector showed that interest in steelmaking could be strengthened by showing that steel careers require digital skills, offer exciting challenges and growth opportunities, and are adequately remunerated.

Showcase the role of steel in reaching circular economy and sustainability goals – By its very nature steelmaking is polluting, but great efforts are being made to make the industry sustainable. The European steel industry is actively reducing its environmental footprint to meet the EU climate targets for 2050, with companies involved in cutting-edge R&D initiatives. Companies' measures for greening the steel industry should be more widely promoted to attract more professionals to work in the steel sector. The full recyclability of the steel should be emphasised as well.

Help jobseekers understand how advances in AI and robotics will reshape the work organisation of the industry – Cluster analysis applied to the sample of students, graduates and jobseekers revealed the existence of five main clusters. One of them finds the sector considerably attractive but considers shift working as a serious constraint. When reaching out to these individuals, it is particularly important to raise awareness on how novel technologies and approaches will disrupt work organisation for several engineering and technical positions. Thanks to automation and robots, many roles offer more flexible working hours, permitting alternation between on-site presence and home working, thus reducing the need for repetitive working shifts. Furthermore, showing the complexity of an Industry 4.0 environment can help increase the respect of the general public towards this

sector. This aspect could be leveraged to attract more candidates to the steelmaking industry who are seeking prestigious occupations. Finally, focusing on smart, digital components of the industry would help ensure an even greater alignment between the perceived skills needs of industry professionals and those of students, graduates and jobseekers. The latter seem to think that the industry gives more importance to manual skills, while digital and data skills are regarded as less relevant.

Showcase the industry's efforts towards health and safety – Despite the industry's increased focus on occupational health and safety, steel plants are still widely associated with health hazards and work-related incidents. The survey results show that the belief that steel companies care about their workers' safety and working conditions can enhance one's willingness to work in the steel sector. Therefore, communication efforts should highlight the health and safety measures taken by companies (e.g.in-firm courses, or changes in company policies and infrastructure to minimise work hazards).

Establish partnerships with innovative steel companies to show what modern steel plants look like – Out of the sample of students, graduates and jobseekers involved in this study, 71% consider jobs in the steel industry as very manual/physical. Only 24% agree that working conditions in steel plants are generally good. Yet, over the years, many companies have made substantial investments in infrastructure, and some plants have become state-of-the-art facilities. Communication activities should focus on highlighting what the daily work of employees really looks like as well as the progress done in improving working conditions over the past years to counter the negative impression about poor working conditions.

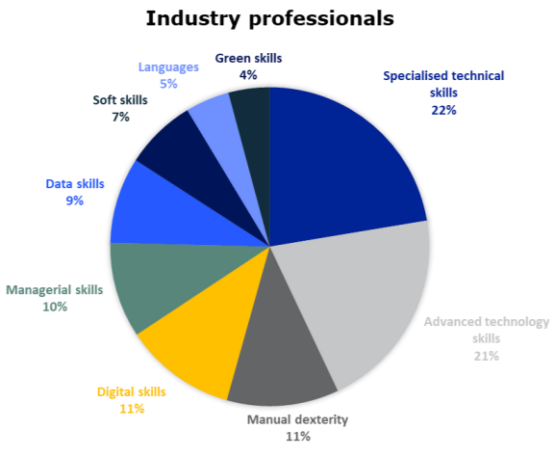
Carry out campaigns promoting careers in metallurgy and STEM-related studies in primary schools and high schools – One of the causes of skills shortages seems to be the lack of students enrolling in relevant STEM-related studies. Steel companies should tackle the challenge of talent shortage early on, engaging with primary schools to increase the attractiveness of STEM and make pupils more familiar with manufacturing (particularly the steel sector). Additionally, partnerships should be sought with high schools and technical schools to implement activities aimed at raising awareness about steelmaking, such as field visits to steel plants, open days with employees, workshops and cultural activities, with a view to re-establish links with the local communities in the areas where production sites are located. Existing initiatives by government and the civil society to support young people's and women's engagement in STEM subjects could also be leveraged.

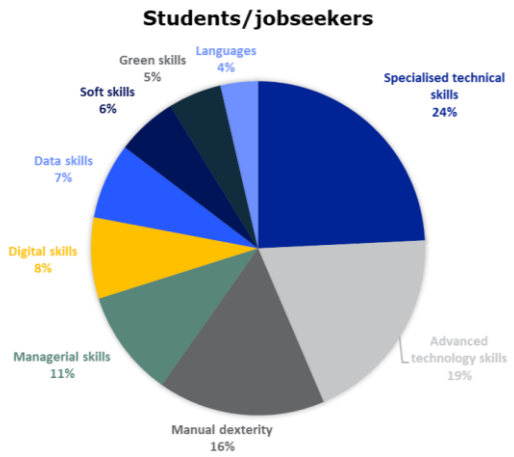
Encourage companies to use their employees as ambassadors in communication campaigns – Findings show that many people have little to no awareness of the variety of career opportunities offered by steelmaking. To counter this trend, EU-level communication campaigns could identify ambassadors in positions that are expected to be in high demand in the industry, such as production managers, maintenance and automation engineers, data governance specialists, design and energy engineers, metallurgists, line technicians and mill operators. These campaigns should not only target graduates and jobseekers, but also address undergraduates and employees with entry level positions, who seem to find the steel sector unattractive, as suggested by the results from the cluster analysis of the sample of students, graduates and jobseekers.

Other findings

The occupational structure of the European steel industry is changing. Repetitive and monotonous roles are gradually disappearing, and employers are looking for candidates with higher levels of qualifications. These are not occupation-specific but are rather characterised by wider and more adaptable skillsets. In general, competencies in engineering, material science, mathematics, physics, and chemistry are seen as crucial to work in the steel industry. Results from two symmetrical MaxDiff exercises showed that, overall, industry professionals' and students, graduates and jobseekers' perceptions of

skills needs are similar, but some key differences exist. Specialised technical skills and advanced technology skills appear to be the most desirable to work in the industry. Manual dexterity scores higher with students and jobseekers than it does with industry professionals. At the same time, digital and data skills are considered of little relevance by students and jobseekers, suggesting they generally associate steelmaking jobs with physical work. Soft skills, languages and green skills rank at the bottom preferences for both groups. However, this seems to change when looking at skills needs in the future. Industry professionals seem to attribute greater importance to both digital skills and green skills. Given the increased focus on sustainable steelmaking and the multiple actions taken by the industry to meet the EU's 2050 environmental targets, environmental awareness and green skills are expected to increase in demand.





Yet, steel companies face skills gaps and difficulties in recruiting the required personnel. Determinants of these gaps can be reduced to three general aspects. First, the difficulty in integrating new technologies and processes among site workers, especially when it comes to older employees. The age range of the steel workforce is comparatively higher than the European average, which impacts workers' ability to integrate new technologies and manage them autonomously. This is particularly relevant for low-skilled workers, who are more likely to be left behind in a context where training and upskilling measures tend to be higher for high- and medium-skilled workers. The lack of a systematic approach to reverse mentorship and the difficulty of applying lifelong learning at company level further hinder the capacity to adapt to fast technological changes.

Secondly, a strong age gap between the workers that are currently employed and prospective employees creates knowledge transfer issues. The industry strongly relies on informal education, with technical know-how being passed on through on-the-job mentorship. Nowadays, this passage of knowledge is at risk, as many steelworkers are approaching the age of retirement and the mismatch between the individuals leaving the industry and those entering it is increasing.

Thirdly, a lack of investment in training and education from steelmaking companies. Last but not least, another root cause behind skills gaps is the insufficient amount of in-house training provided by companies, coupled with a general lack of talent management strategies. When available, training provision is generally considered to be too late with respect to the innovations it tries to tackle.

The challenges related to the competitiveness of the European steel industry call for forward-looking strategies to ensure the recruitment and retention of qualified personnel. Educational programmes taught in universities and VET institutions appear to have broadened in scope. Consequently, steel-specific degrees are progressively being eliminated in favour of broader degrees. Similarly, when looking into national and regional policies, it can be noted that skills-related strategies do not target the steel sector specifically. Therefore, up-/reskilling actions targeting sector-specific competencies are generally provided in-firm, as companies are seen as the most suitable place to learn such

competencies. Yet, exchanges and partnerships between companies and educational institutions are particularly important and increasing in number, with companies engaging in apprenticeship schemes and traineeships or permitting use of company facilities to students as case studies for their thesis (Master's or PhD's).

Most company representatives involved in this study welcomed the idea of a stronger cooperation between industry, public institutions and education providers, with each party being regarded as an equal partner. Dual education comprising school-work alternation and industrial training is considered the most effective tool to familiarise students with the industry and increase their job-readiness level. Policymaking can also significantly influence the industry's training provision, as policies in specific sectors (e.g. environment, energy efficiency, Industry 4.0, migration, gender equality, and education) can influence the way companies manage their human resources (HR). Finally, pooling knowledge on skills needs should be marked as a priority for the sectoral social dialogue at EU level.

1. INTRODUCTION

This chapter provides an overview of the objectives of the report and describes its structure, guiding the reader in the navigation of the text.

The present report presents the main outcomes of the study "European vision on steel-related skills and supporting actions to solve the skills gap today and tomorrow in Europe" launched in December 2018 in the framework of the "Blueprint for sectoral cooperation on skills: Towards an EU strategy addressing the skills needs of the steel sector" initiative. The Blueprint is part of a larger policy programme for strategic cooperation called "New Skills Agenda for Europe", which aims to boost employment and employability in key sectors of the European economy. The initiative that led to this study is part of the second wave of Blueprints for sectoral cooperation, which cover four industrial sectors: additive manufacturing, construction, maritime shipping and steelmaking[1]. Its goal is "to foster skills development in the steel sector especially in a view to boost employment and employability and overcome gaps, shortages and mismatches between skills offer and demand"[2]. To achieve this, the Blueprint calls for the development of a comprehensive picture of the situation of the steelmaking workforce through research, including an analysis of current and future skills needs as well as a state-of-play description of different national higher education, vocational and training systems that cater to the steel industry.

To meet the abovementioned objectives, research was conducted to gather perceptions on current and future skills needs from key stakeholders active in the sector (including representatives of the industry, workers' organisations, education providers at different levels and public authorities), as well as students, graduates and jobseekers with a STEM-related background[3]. The study compared the skills needs of the industry with the educational offering, both in higher and vocational education, in seven target countries selected by the European Commission based on their significant production and export levels of steel (i.e. Finland, France, Germany, Italy, the Netherlands, Poland and Spain). In addition, it touched upon the issue of policies and initiatives for up-/reskilling the workforce in the steel sector. Lastly, the study also shed light on the image of the steel sector and careers within it, identifying the main drivers and barriers that may affect the choice to take up a career in the steel sector.

Data was collected using different methods, including a literature review, as well as empirical insights from stakeholders across Europe using quantitative and qualitative techniques (a detailed description of the research methodology is provided in Chapter 3). The data collected and generated has a wide geographical spread, covering all Member States (EU 28), with a specific focus on seven countries: Finland, France, Germany, Italy, the Netherlands, Poland and Spain. The results presented in this document derive from the synthesis and analysis of these different datasets.

Without aiming to be exhaustive, given the complexity of the steel industry and the great variety of professional profiles and competencies needed in steelmaking, this report sets out to provide a description of the skills supply and demand and the factors that affect them. Based on the findings, the report draws a number of conclusions and develops recommendations on how to address the skills gaps in the European steel industry and align educational programmes with the needs of the industry.

The document is structured as follows:

- **Chapter 2: Problem Statement** — This chapter briefly presents the context that motivated the study and introduces the main research questions that guided it.

[1] The first wave of Blueprints was launched in 2017, and covered five sectors: automotive, maritime technology, space-geo information, textile, clothing, leather and footwear, and tourism

[2] European Commission, Tender specifications, EASME/COSME/2018/019, "Blueprint for sectoral cooperation on skills: Towards an EU strategy addressing the skills needs in the steel sector", 2018, p. 6

[3] STEM stands for the disciplines of Science, Technology, Engineering, and Mathematics.

- **Chapter 3: Approach and Methodology** — This chapter describes the methodological approach adopted to address the research questions of this study, covering desk research, semi-structured interviews, a descriptive questionnaire, two multi-component surveys, national workshops and EU-wide webinars.

- **Chapter 4: Research Outcomes** — This chapter is structured to reflect the analysis of the aggregated data collected through the abovementioned research methods. The chapter covers the following aspects:

  - An overview of the evolution of the steel industry in recent years, with a specific focus on the impacts of the financial and economic crises and the emergence of new competing economies in the global steel market

  - A section highlighting insights into the image of the steel industry, looking specifically at the negative aspects and misconceptions that prevent people from choosing a career in steelmaking

  - A comprehensive and future-oriented description of skills needs in the sector, covering both the expectations of industry professionals and the perception that graduates and jobseekers in STEM disciplines have of the steel industry. In addition to current skills needs, this section also covers how skills are expected to evolve in a five-year horizon, identifying the underlying trends and changes in the steel industry

  - A state-of-play description of the measures available to up-/reskill steel workers and to train potential hires, covering policymaking as well as national higher and vocational education systems, without leaving out industry-led initiatives

- **Chapter 5: Conclusions** — This chapter summarises the main findings of the study and formulates general conclusions based on these findings.

- **Chapter 6: Recommendations** — Building on the findings presented in Chapter 4, the report presents a set of recommendations addressed at different stakeholders in the steel industry.

2. PROBLEM STATEMENT

This chapter presents the context of this study, introduces the research questions, and briefly describes the background against which they were formulated. Starting from the role of the industry in European society, the chapter takes stock of the main challenges faced by European steelmaking and explains how this study fits in the initiatives implemented by the European Union to face such challenges.

Steelmaking is a key industrial sector in Europe. The history of the European Union (EU) points towards its strategic importance, as the European project itself was initiated with the trade of coal and steel. To facilitate the trade of these two resources, six European countries came together to form the European Coal and Steel Community (ECSC). Officially established in 1951 through the Treaty of Paris, signed by Belgium, France, Italy, Luxembourg, the Netherlands and West Germany, the ECSC was the first organisation based on the principle of supranationalism and represents the forerunner of the modern EU. The ECSC was dissolved in 2002 (with the expiration of the Treaty), and the EU now integrates numerous other industries. Steelmaking, however, maintains a strategic importance in the EU economy, as it is one of the most important resources for Europe's industrial base.

Until the end of World War II, the use of steel was strongly linked to better warfare capabilities. In the wake of the conflict steel was needed to drive reconstruction across the continent. Nowadays, steel has a much more diversified use, and its market is focused on several downstream industries such as automotive, construction, mechanical engineering and metal ware (e.g. white goods). Among steel-using industries, automotive and construction alone account for approximately 54% of the total finished steel demand in the EU[4]. According to the most recent figures published by the European Steel Association (EUROFER), the steel sector creates EUR 148 billion of Gross Added Value in the EU, and supports 2.6 million jobs (including 330,000 direct jobs, 1.6 million indirect jobs, and 701,000 induced jobs)[5]. With a total output of 169 million tonnes (approximately 10% of total production), the EU is the second major steel producer worldwide after China. On the other side of the trade balance, the EU is the largest steel importing economy, according to the Organisation for Economic Co-operation and Development (OECD)[6].

Over the last 30 years, the global steel market has undergone substantial changes. The 1980s and 1990s saw significant developments, including recruitment freezes, which have led to the creation of a marked age gap (and consequent knowledge gap) between older workers and new hires. More recently, the 2008 economic and financial crises had stark repercussions on the European steel industry. The automotive and construction sectors were severely impacted by the crises, leading to a significant reduction in steel demand. This came with important social and economic consequences, including plant closures and large-scale restructuring of steel companies. Between the start of the crises and 2013, 40,000 jobs were lost. In the long term, the industry experienced a contraction in employment of about 78,000 jobs[7]. Against the backdrop of the crises, production costs have increased significantly, especially with regard to raw materials (e.g. iron ore and coking coal). According to recent estimates, the price of iron ore has experienced a tenfold increase between 2001 and 2010[8]. Electricity prices have also increased with a rise of about 8% between 2005 and 2012.

The European steel industry is also faced with increasingly severe market conditions. This is mainly due to competition from emerging countries. China dominates the steel production landscape with a total output of over 830 million tonnes (i.e. approximately

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[4] EUROFER, European Steel in Figures 2019, 2019, p. 7
[5] Ibid., p. 7
[6] OECD, Steel Market Developments: Q4 2017, OECD Publishing, Paris 2018, p. 41
[7] European Commission, "Action Plan for a Competitive and Sustainable Steel Industry in Europe", COM(2013) 407 final, European Commission, Brussels, 11.06.2013
[8] Ibid.

50% of total production), and Japan has an output of approximately 100 million tonnes. At the same time, countries such as India, South Korea and Turkey have also increased their output, representing a substantial share of European imports. For instance, imports from India doubled in 2017, while those from Turkey increased by 65%[9]. The emergence of new competing economies also influences the demand for raw materials with substantial repercussions on price.

The increased international competition is exacerbated by the difficulty of creating a level-playing field among competing economies, which stems from discriminating and imbalanced practices adopted by some countries. These include trade restrictions in the form of tariffs and non-tariffs measures, dumping and predatory commercial behaviour[10]. For instance, Chinese steel is flooding the global market, creating disruptive shocks in domestic demand and amplifying excess capacity. Further disruption is created by trade barriers such as the tariffs on European steel imposed through United States (US) Section 232 measures. Additionally, European producers are held to very high quality and sustainability standards, which do not apply in other countries, where companies can take advantage of less demanding regulations with regard to pollution and workers' protection to produce steel at a cheaper price.

All the above have severely impacted the European steel labour market. The output of steel plants has decreased significantly, leading to the closure of several sites, with the consequent contraction in the workforce employed by the industry. At the same time, the crisis of the sector was highly detrimental to its image as a reliable employer, driving young people away and creating problems of knowledge transfer with the current workforce, who are approaching the age of retirement. This situation is further aggravated by the transformation that the industry is experiencing under the impulse of Industry 4.0 (digital) technologies and lean production processes, which the current work base appears to be struggling to integrate.

To meet the challenges affecting the steel industry, the European Commission has adopted several measures over the last years:

- To counter unfair competition and ensure the competitiveness of the European steel industry, the European Commission has used the Trade Defence Mechanism (TDM) to put in place a large number of defence measures targeting unfair imports of steel products. These include 47 anti-dumping and anti-subsidy measures.
- A first step towards a common policy approach to excess capacity was achieved in 2017, when the Commission gathered the key international stakeholders of the steel industry in a Global Forum on Steel Excess Capacity. During the Forum, participants agreed on common policy solutions to reduce market-distorting subsidies, decrease over-capacity, and re-establish the role of the market.
- On 11 June 2013, the European Commission adopted the "Action Plan for a competitive and sustainable steel industry in Europe", which includes a series of measures and recommendations to ensure the competitiveness of European steel and to create an enabling environment for the European industry. The Action Plan includes measures to ensure that steel production is supported by the right regulatory framework. By countering unfair trade practices, allowing adequate access to raw materials and affordable energy supply, boosting demand from steel-consuming industries (for instance, with the CARS 2020 strategy for the automotive sector) and promoting the competitiveness of sustainable steel production, the steel industry would get a much needed boost.

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[9] EUROFER - The European Steel Association, '84th Session of the OECD Steel Committee - EU Steel Market and Challenges' 3.05.2018, See: http://www.oecd.org/industry/ind/84th_OECD_Steel_Committee_Item_10-3_EUROFER.pdf, Last visited on 14.06.2019

[10] European Commission, "Action Plan for a Competitive and Sustainable Steel Industry in Europe", COM(2013) 407 final, European Commission, Brussels, 11.06.2013

The Action Plan also includes a social dimension, which acknowledges the importance of preserving employment in the industry and opens several actions from the European Commission, Member States and the industry to tackle the effects of industrial transformation on the workforce composition. These measures will ensure that employees are given the opportunity to acquire the skills necessary to stay relevant in an increasingly competitive environment.

The challenge related to the competitiveness of the European steel workforce provides the context in which the present study was launched. The steel sector is changing at a fast pace, competition is fiercer, and new skills are in demand. The EU cannot and does not intend to compete on cheap labour and low social standards. Rather than engaging in a price war with other steel producing economies, the EU intends to become a leader in innovative and high-quality products and stay ahead of the technological curve by investing in new processes and technologies. This is clearly stated in the communication "Steel: Preserving sustainable jobs and growth in Europe", published in March 2016[11] and reiterated in the newly published communication "A new industrial strategy for Europe"[12]. As a consequence, actions are required to build and foster a competitive workforce characterised by innovation, quality and technology. To tackle this challenge, the European Commission has engaged with stakeholders from the industry and civil society in a wide array of initiatives aimed at bridging gaps between the needs of the industry and the availability of a qualified workforce.

Since 2006, the Sectoral Social Dialogue Committee on Steel, gathering EUROFER, the European Steel Technology Platform (ESTEP) and the European union of industrial workers IndustriALL provides the main forum to discuss the challenges faced by the steel industry and its workers. Among others, the key priorities of the Committee include[13]:

- strengthening the industrial base;
- global competitiveness of the European steel industry;
- apprentices in the European steel industry, boosting employment with high quality jobs;
- talent management (recruiting and retaining talents);
- participating in the High-level Expert Group (HLG) on energy intensive industries;
- contributing to the Steel Action Plan;
- climate change policy;
- industrial policy on raw materials and trade;
- dealing with an ageing workforce.

Moreover, the competitiveness of the European steelmaking workforce has been a long-standing issue for both sectoral organisations and research institutions. The European Metalworkers' Federation (EMF, now IndustriALL) created a Training Working Group with the aim to reflect industry developments in relation to skills and trainings. Between 2004 and 2007, the project EDLESI (Equality and Diversity Learning in the European Steel Industry) and the New Steel Industry Challenges (NSIC) were implemented (under the European Commission's Education and Training programme Leonardo da Vinci) to address skills needs emerging at the turn of the century. In recent years, ESTEP has concentrated on education and training, to allow for the development of new products and processes thanks to highly skilled employees, with the end-vision of safeguarding the sector's competitiveness[14]. For instance, ESTEP has set up a specific working group for steelworkers of the future (Working Group People). Members of this working group are responsible for contributing to the supply of highly skilled employees, ranging from scientists to managers,

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[11] European Commission, "Steel: Preserving sustainable jobs and growth in Europe", COM(2016) 155 final, European Commission, Brussels, 16.03.2016

[12] European Commission, "A new industrial strategy for Europe", COM(2020) 102 final, European Commission, Brussels, 10.03.2020

[13] 'Sectoral Social Dialogue - Employment, Social Affairs & Inclusion - European Commission, 2018, See: http://ec.europa.eu/social/main.jsp?catId=480&langId=en&intPageId=1853, Last visited on 14.06.2019

[14] "ESTEP - ESTEP at a Glance", See: https://www.estep.eu/estep-at-a-glance/, Last visited on 14.06.2019

and to enhance the European steel industry's competitiveness[15]. Steel stakeholders also collaborated to launch an industry-led training module (with support from the European Commission's Education and Training programme Leonardo da Vinci), Greening Technical Vocational Education and Training (GT VET), to address the need for new skills related to sustainability in the steel sector.[16]

These actions have provided the basis to undertake larger-scale projects to tackle skills development in the steel industry through a structured and long-term approach. In 2016, the European Commission adopted the policy programme "New Skills Agenda for Europe", which consists of 10 actions to allow European workers and jobseekers to access adequate training and skills to integrate into the European labour market. As part of the Agenda, the Commission launched the Blueprint for Sectoral Cooperation on Skills, a strategic cooperation framework between key stakeholders in specific economic sectors. Two waves have been launched so far. The first wave included five sectors: automotive, maritime technology, space-geo information, textile, clothing, leather and footwear, and tourism. The second wave complemented the first with four additional sectors: additive manufacturing, construction, maritime shipping and steelmaking. The "Blueprint for Sectoral Cooperation on Skills" in the steel sector was launched in 2019 to:

- improve the competitiveness of the European steel industry;
- raise awareness about careers in the steel sector and improve the industry image;
- mitigate the effects of retirements and departures from the sector;
- provide adequate workforce to foster innovations.

As part of the "Blueprint for Sectoral Cooperation on Skills" in the steel sector, the study "European vision on steel-related skills and supporting actions to solve the skills gap today and tomorrow in Europe" was launched to gain a clear understanding of the mismatch between skills demand and supply in steelmaking. The goal was to lay the foundations for a long-term skills strategy for the sector. The study focuses on seven specific target countries, i.e. Finland, France, Germany, Italy, the Netherlands, Poland and Spain, with a view to gain an understanding of the current situation of the workforce in the steel sector and compare it with the educational offer. The study identifies the main trends in skills needs of the European steel industry, gaps and mismatches as well as the factors behind them. In addition, it delivers a country-specific analysis of each target country, looking at the situation of different national steel industries and at the educational programmes available in those countries. The present report summarises the findings of the study, defining a state-of-play of the labour market in the European steel industry.

The present study adopts a sectoral approach rather than an occupation-specific approach. It focuses on skills related to the production and refinement of steel[17]. It therefore considers the competencies needed by workers employed in areas such as melting shops, finishing areas, rolling mills, maintenance and expeditions, quality control, health and safety, and R&D.
The findings and recommendations of this study will feed into a larger analytical framework, which is provided by the Erasmus+ Blueprint project "New Skills Agenda Steel": Industry-driven sustainable European Steel Skills Agenda and Strategy" (ESSA), that started in January 2019. More generally, this study should serve as a basis for informed actions to tackle the challenge outlined above.

The following chapter details the methodology adopted to meet the objectives of this study.

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[15] "ESTEP - WG People", See: https://www.estep.eu/estep-at-a-glance/working-groups/wg-people/, Last visited on 14.06.2019
[16] See: https://www.estep.eu/assets/GT-VET/Greening-technical-vocational-education-training-Flyer-english.pdf, Last visited on 14.06.2019
[17] For the purpose of this study, the term "steel sector" follows the definition provided in Article 2(29) of the Commission Regulation (EC) No 800/2008 declaring certain categories of aid compatible with the common market in application of Articles 87 and 88 of the Treaty (General Block Exemption Regulation).

3. APPROACH AND METHODOLOGY

This chapter provides a brief description of key activities that were carried out to meet the objectives of the study. A combination of methods was employed, namely literature review, content analysis, interviews, surveys, workshops, webinars and stakeholder consultation.

As mentioned above, the present study focused on skills related to the production and refinement of steel, following the definition provided in Article 2(29) of the Commission Regulation (EC) No 800/2008 (General Block Exemption Regulation), where "'steel sector' means all activities related to the production of one or more of the following products:

(a) pig iron and ferro-alloys:
pig iron for steelmaking, foundry and other pig iron, spiegeleisen and high-carbon ferro-manganese, not including other ferro-alloys;

(b) crude and semi finished products of iron, ordinary steel or special steel:
liquid steel cast or not cast into ingots, including ingots for forging semi finished products: blooms, billets and slabs; sheet bars and tinplate bars; hot-rolled wide coils, with the exception of production of liquid steel for castings from small and medium-sized foundries;

(c) hot finished products of iron, ordinary steel or special steel:
rails, sleepers, fishplates, soleplates, joists, heavy sections 80 mm and over, sheet piling, bars and sections of less than 80 mm and flats of less than 150 mm, wire rod, tube rounds and squares, hot-rolled hoop and strip (including tube strip), hot-rolled sheet (coated or uncoated), plates and sheets of 3 mm thickness and over, universal plates of 150 mm and over, with the exception of wire and wire products, bright bars and iron castings;

(d) cold finished products:
tinplate, terneplate, blackplate, galvanized sheets, other coated sheets, colled-rolled sheets, electrical sheets and strip for tinplate, cold-rolled plate, in coil and in strip;

(e) tubes:
all seamless steel tubes, welded steel tubes with a diameter of over 406.4 mm."[18]

To identify the main needs of the industry in terms of current and future skills and gain a thorough understanding of the measures and initiatives available for workers and jobseekers in the steelmaking industry, the study adopted a stakeholder-centric approach. While a first set of findings emerged from the extensive review of the currently available literature on the subject (over 250 sources), additional layers were added by using qualitative and quantitative research methods that drew first-hand input from a wide variety of stakeholders. Furthermore, the study team analysed the content of 100 job advertisements for vacancies in the steel industry and carried out 65 semi-structured interviews, one online questionnaire on initiatives to support skills development in the steel sector and two multi-component surveys (one addressing steel professionals about skills needs and expectations, and one for students, recent graduates and jobseekers with a STEM-related background, about career expectations and the image of the steel sector – 2,199 respondents in total). It then validated the findings and recommendations through national workshops in the seven target countries as well as two EU-wide webinars.

Data collection occurred throughout Europe (EU-28), but additional in-depth research was carried out for seven target countries, namely: Finland, France, Germany, Italy, the Netherlands, Poland and Spain. The national profiles of the seven countries are annexed to this report (see Annex 7.3 National profiles).

During data collection, six datasets were put together, notably:

1. desk research sources;
2. online job advertisements (hereafter referred to as "job ads");

[18] European Commission, "Commission Regulation (EC) No 800/2008 declaring certain categories of aid compatible with the common market in application of Articles 87 and 88 of the Treaty (General Block Exemption Regulation)", Article 29(2), Official Journal of the European Union L 214, 09.08.2008, pp. 17-18

3. interviews;
4. questionnaire responses;
5. survey data for steel professionals; and
6. survey data for students and jobseekers.

Each dataset was first analysed individually. In the case of the two multi-component surveys, the study team performed advanced analytics (e.g. inferential analysis, factor analysis and linear regression, analyses of variance, conjoint analysis, etc.) to go beyond baseline observations and offer an insightful account of the industry expectations concerning (a) current and future skills needs in steel production, and (b) students and jobseekers' perceptions about careers in the steelmaking industry.

The triangulation of the various research techniques led to the conclusions (Chapter 5) and subsequent policy recommendations (Chapter 6).

Figure 1 illustrates the overall approach and outputs of the study, whereupon each method is presented in further detail in subsequent sections.

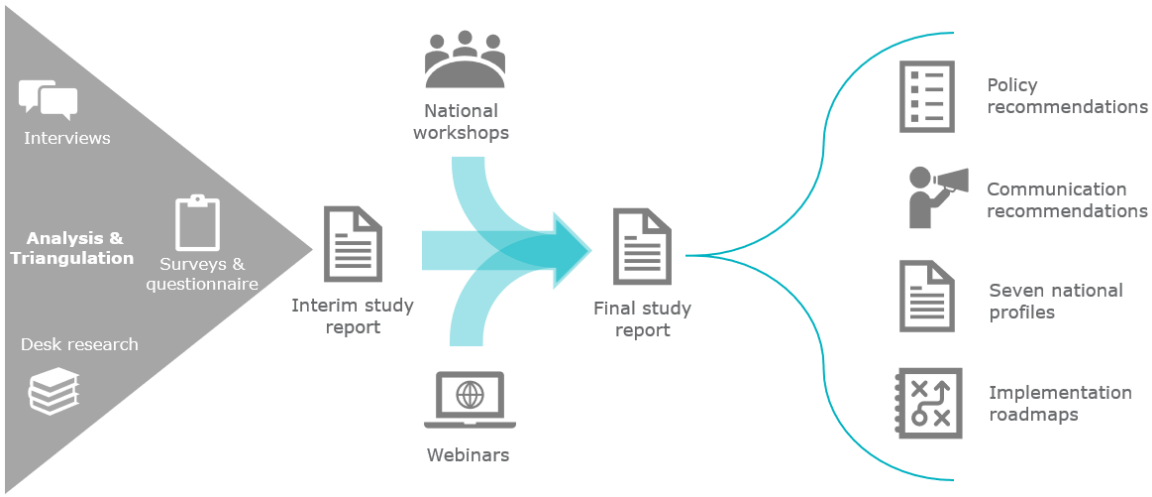

Figure 1 — Approach and outcomes

3.1. Desk research and content analysis of job ads

The purpose of desk research was twofold: to obtain a comprehensive view of current and future skills needs and to gain a state-of-the-art overview of existing measures to both train future workers for the sector and to increase the competencies of existing workforce.

To achieve these goals, the study team gathered and reviewed approximately 250 sources, covering different types of documents, including:

- annual reports with statistics by Eurostat, the OECD, World Steel, EUROFER and ESTEP;
- reports of the OECD Steel Committee;
- national strategic development plans for employment and re-employment;
- working documents and websites of steel companies as well as trade associations and trade unions;
- conference proceedings;
- European Commission's communications;
- books and academic articles in the field;
- specialised journals and articles.

Although desk research provided a solid basis for the study, it only allowed to retrieve publicly available secondary information. Sources were not necessarily up to date nor did they provide insider information. Furthermore, the number of sources on perceptions and

expectations of stakeholders proved to be limited. To circumvent these constraints, an additional desk research layer was added. An extensive content analysis was conducted of job ads posted by steel companies or recruitment agencies on online job portals or company websites. This helped provide up-to-date information on skills and qualifications desired by the employers for various job positions. Additionally, it gave some indication of what makes the vacancy announcement seem trustworthy and appealing. Since vacancies are often advertised online, the research team could gather material from multiple countries.

100 job ads from across Europe were analysed. Job ads were coded according to a common template, which tracked aspects such as education and seniority required, desirable skills, knowledge and attributes, salary, benefits etc. While the analysis had a specific focus on vacancies from the main European steel producers (e.g. Tata Steel Europe, ArcelorMittal, Salzgitter AG, Voestalpine, Outokumpu etc.), medium-sized enterprises were also taken into account. This analysis provided a comprehensive picture of the expectations of steelmaking companies in terms of skills, knowledge, qualifications and other attributes in different countries and across different segments of steel production.

3.2. Interviews

Secondary data collection was complemented by semi-structured interviews that helped to explore the perceptual dimension in more detail, particularly regarding the image of the steel sector and the most needed skills for the industry. Interviews also covered the initiatives carried out to address those needs. The interview process was split into two rounds, which were carried out in parallel. The first round gathered perceptions on the most needed skills in the industry and involved participants from all around Europe. The second round focused on the project's target countries and tried to acquire a comprehensive view of the measures and initiatives in place to facilitate the acquisition of those skills.

The interviews targeted a wide array of stakeholders. Overall, the sample selected for the interviews were broken down into the following categories:

Table 1 — Stakeholder categories for the interview sample

Stakeholder category	Round
Industry stakeholders, included representatives from steel producer associations, managing directors of steel companies, HR managers, R&D managers, and selected managerial profiles with a track record of activities at EU level (e.g. ESSA members and members of ESTEP's Sectorial Social Dialogue Committee on Steel)	Both first and second round
Education providers at all levels, including university professors, researchers, trainers of private and public VET centres, and learning and training departments of steel companies and sectoral associations	Both first and second round
Trade unions and associations representing steel workers, with a specific focus on high-level profiles with strong connections with the industry and local government	First round only
Civil servants from national and regional authorities (e.g. ministries, national committees and agencies, and regional administrations)	Second round only

The final interview sample was composed as follows:

- in the first round, 33 stakeholders were involved – 11 industry stakeholders, 10 education providers and 12 trade union representatives

- the second round included 32 stakeholders – 14 industry stakeholders, 14 education providers and 4 civil servants.

The study team opted for semi-structured interviews to ensure comparability among individual data via a common interview guide. To achieve optimal results, six versions of the interview guide were created: three for the first round (one for each stakeholder group, i.e. industry representatives, education providers and trade union representatives) and three for the second round (one for industry stakeholders, one for education providers and one for public authority representatives). Altogether, the guides covered the following sections: current skills needs, future skills needs, main trends affecting the steel industry, educational programmes and skills development initiatives, other measures and policies, the image of the steel sector, careers in the steel industry, and tools used for talent recruitment.

3.3. Questionnaire for authorities

To gather detailed information about the initiatives that have been developed to address skills needs or foster skills development in the steel sector, an explorative questionnaire was designed. This questionnaire was intended to complement the data collected through desk research and the interviews, providing a quantitative layer to the study.

The questionnaire was developed using Sawtooth software and circulated extensively by posting a direct link in relevant LinkedIn groups and by sharing it via email with companies, universities, training centres and policymaking bodies. The focus was on organisations that implemented or are implementing specific initiatives to promote the development of skills and competencies that are relevant to the steel sector, such as:

- Educational programmes at all levels (BSc, MSc, PhD, etc.);
- Vocational training;
- Exchange programmes;
- Traineeships, dual learning schemes, summer jobs;
- Educational policies;
- Public or private funded projects;
- Partnerships and framework programmes;
- Workshops;
- E-learning modules;
- Serious games and simulations.

Despite the dissemination efforts, the final sample only comprised 16 respondents. This can be explained by the fact that only a limited number of initiatives exist that simultaneously target skills development and the steel sector. This finding was also confirmed by both desk research and expert statements. Measures and policies for skills development tend to have a broader industrial scope. Although the number did not allow for advanced quantitative analysis, the study group could still gather insights into the initiatives covered by the sample by assessing them along three fundamental aspects:

1. the demographic profile of the initiative (including duration, target groups, geographical scope, etc.)
2. implementation barriers encountered and possible success factors
3. perceived impact from the perspective of the respondent.

Because of the limited response rate, the data was complemented with the information collected in the interviews and additional targeted desk research about the initiatives mentioned during the interviews.

3.4. Multi-component surveys

Finally, in addition to the interviews, which provided a qualitative angle to the study, and the questionnaire on initiatives, a further layer of primary data was added using two multi-component surveys. The surveys addressed two different groups, i.e. steel professionals and students, recent graduates and jobseekers from a STEM-related background. Both

surveys were designed using Sawtooth. This software was selected as it allows for advanced analytical features, such as conjoint analysis, which helped to investigate respondents' preferences based on utility scores (see more on the analysis in Chapters 3.5 and 4).

Responses were collected by combining direct emails to relevant contacts with crowdsourcing through Clickworker, a platform with a wide pool of European members. Crowdsourcing was selected as the most efficient way to ensure a representative sample of respondents across Europe. It is a useful tool for implementing surveys, as it offers some methodological advantages, namely anonymity (therefore low social desirability bias), completion speed, and population diversity. Moreover, participants have an incentive to complete the survey as they are financially compensated for filling it in. Responses were monitored regularly to ensure a balanced composition of the sample. To avoid any bias related to the paid participation in the survey, respondents were filtered at the beginning of both surveys (to make sure the inclusion criteria were respected as much as possible) and through additional control measures (e.g. attention filter before the end of the survey, completion time). More details on each of the surveys are provided below.

Survey 1 — Industry professionals

One multi-component survey investigated current skills needs and skills gaps from the perspective of the steel professionals in charge of selecting and training the personnel. The survey entailed multiple components to identify factors that influence the perception of skills gaps as well as upskilling/reskilling needs both at company level and at sectoral level (see below). Among others, the survey included items (questions) to get a clearer view on what efforts are being made by the companies to upskill and retain their staff, as well as changes that will affect the industry and its competitiveness.

Given the scope, the survey targeted professionals active in the steel industry, with a specific focus on HR managers and recruiters, and for smaller companies, managers in charge of new hires. The survey was distributed through mailing lists, relevant LinkedIn and Facebook groups, and most importantly, through the network provided by international and national contact points such as EUROFER, IndustriALL, World Steel and several national producers' associations. In addition to that, direct contacts were made with steel companies across Europe to ensure an adequate outreach of the survey. Given the initial low response rate, the survey was also disseminated through Clickworker. Eventually, 868 people took part in the survey. However, incomplete responses were discarded (106). Moreover, respondents were filtered based on a set of two initial questions (535) and based on their completion time: all outliers with a completion time below average were excluded as speeders (30). After data cleaning, 197 responses were retained (73.9% exclusion rate[19]). Data was analysed with Sawtooth built-in analysis tools and SPSS.

The survey included five main components, namely:

- Demographics and additional variables (e.g. years of recruiting experience);
- Auxiliary variables, e.g. company's preparedness to meet skills needs, industry changes, company's digital readiness, attitudes towards training and education;
- Skills needs and gaps: quantification and ranking;
- Independent variables: possible factors causing skills needs and gaps;
- Survey end and behavioural intent component.

The first component covered questions about the profile of the company the respondent works for and the respondent him/herself (in particular, the years of experience in recruiting in the sector, in recruiting overall and in providing training). These demographics were used to check for possible correlations with perceived level of skills gaps.

[19] While this rate may seem very high, it is a good indication that the respondents who were eventually retained meet the inclusion criteria (being a steel professional with several years of experience, preferably in hiring and/or training the workforce) and their answers can be relied on for the analysis.

The set of auxiliary variables included aspects that may be driving the need for skills initiatives in the steel sector and the skills needs at company level as well as the perception of the existence of skills gaps. These may be external factors (changes happening in the industry), at company level (e.g. frequency of provision of training) or attitudinal factors. They have all been tested as independent variables and through linear regression to explain the variance in the dependent variables.

The third component was a Max-Diff exercise, the purpose of which was to quantify and rank respondents' preferences in terms of skills that are needed for the steel sector based on utility scores. Specifically, Max-Diff involves survey takers repeatedly indicating the best and worst options out of a given set. As multiple users progress through the sets, the researcher gets a better picture of what is most important and what is least important in situations where trade-offs and choices are required. This means that one gets an idea of whether a certain skill is needed or not, as well as its relative importance in comparison to other skills.

The fourth component refers to some additional items that were tested as independent variables since the literature and interviews suggested that they might affect skills needs and gaps. These variables included, among others, the growing automation of processes, the increased use of technologies, the ageing of the workforce, competition from non-European countries, and mismatches in workers' expectations.

The survey ended with a thank-you note and a final question on the respondent's willingness to be involved in initiatives supporting the up-/reskill of the workforce in steel and the upgrade of educational programmes and VETs for workers in the steelmaking industry. This question was included as it was considered a proxy for the respondents' behavioural intentions and was used to check its correlation with other variables, and especially the dependent one (perceived skills gaps).

Survey 2 — Students and jobseekers

The second survey was aimed at students who are about to complete a degree or enter the job market, i.e. jobseekers. An important inclusion criterion for the sample was for respondents to have a STEM-related background. The disciplines that fall under the STEM label are considered as the most relevant to the steel industry. Therefore, such students were regarded as the primary pool of interesting candidates for steel careers but may opt for other industries for their professional lives. Therefore, it is worth understanding what matters to them and their opinion of the steel sector as a possible career choice. This survey provided a robust complement to the first one, as it gave evidence-based insights into factors that may affect stakeholders' willingness to work for the steel industry (e.g. the negative image of steelmaking). Furthermore, it also offered insights into the skills that are thought to be the most important to get a position in the industry, showing that respondents' perceptions are quite in line with the expectations of steel professionals.

This second survey was also created on Sawtooth and disseminated via crowdsourcing (Clickworker platform). Crowdsourcing was supplemented through direct mailing to balance the geographical spread of respondents. Like Survey 1, responses were regularly monitored and data was cleaned to ensure the highest possible quality of the answers. More specifically, 4,846 people participated in the survey. 413 survey takers provided incomplete responses and were therefore discarded. 1,643 participants were filtered right at the beginning of the survey based on two ad-hoc filters, which helped ensure that participants actually matched the inclusion criteria. Finally, a control question served to exclude respondents who were not paying attention when completing the survey (788). After data cleaning, the sample amounted to 2,002 valid responses (58.7% exclusion rate). Also in this case, results were analysed with Sawtooth built-in analysis tools and SPSS.

The survey included six main components, namely:

- Career aspirations;
- Preferences for careers in the steel sector (Choice-Based Conjoint, i.e. CBC);

- Skills needs: quantification and ranking;
- Perceptions of steel-related careers;
- Demographics and auxiliary variables;
- Survey end and behavioural intent component.

The first component included scaled questions (Likert 1-7) concerning aspects that make a vacancy interesting for the respondent (regardless of the industry). This provided input for recommendations on how to attract and retain talents, comparing respondents' aspirations with what is currently offered by steel companies (for instance, on the basis of findings from the job ads analysis), but also with the perceptions respondents have of careers in the steel industry.

The CBC component was used to identify the preferences of respondents concerning steel careers by looking at the relative importance of different features of a work position (e.g. type of contract, type of work, place of work) as well as the relative importance of the various attributes of each feature (for instance, for the feature "type of contract" the attributes were "full time – permanent", "full time – temporary", "part time – permanent", "part time – temporary"). This exercise allows the researcher to understand features with the greatest importance for respondents, strongly influencing their choice when selecting a new career, and to check which attributes act as drivers for the choice and which ones act as barriers.

The third component comprised a Max-Diff exercise that mirrored the one described in Survey 1. Once again, the purpose was to quantify and rank respondents' beliefs concerning skills needed in the steel sector. Because the exercise was the same in the two surveys, it was possible to directly compare the results and identify mismatches and similarities between the expectations of steel professionals (the real market needs) and the beliefs of students, graduates and jobseekers.

The fourth component helped gather information about the image that stakeholders have of the steel sector and understand whether any statistically significant relation exists between respondents' perceptions of the sector and their willingness to work in it.

The fifth component explored demographics and other auxiliary variables such as the respondent's familiarity with the steel sector (e.g. having visited a steel plant, having worked in the sector before, having had a traineeship in the steelmaking industry), which may have an influence on the dependent variable (willingness to work in the steel sector).

Just like Survey 1, a thank-you note closed the second survey. It was followed by a last question on the respondent's willingness to receive more information concerning careers in the steel sector, which was used as a proxy for the respondents' intentions and tested for correlation with other variables, especially the dependent one.

3.5. Analysis

Given the different natures of the data collected through the various research activities described above, separate datasets were created and analysed individually following a set of key research questions about skills needs, gaps, and mismatches, the image of steel-related careers, existing and desirable measure to up-/reskill the workforce or improve the image of the sector. The research outcomes chapter of the present report is structured along these research topics.

For the desk research, the job ads and the interviews, qualitative analysis methods were used to highlight patterns and divergences. Desk research sources and job ads were coded according to common templates that helped single out relevant information. The interview guides could be used to classify information and compare the answers from one stakeholder group with those from the others. Data was analysed from different perspectives, such as stakeholder category, country, and organisation size. For the questionnaire on initiatives, a mix of qualitative and quantitative (i.e. descriptive statistics) analysis was used.

For the surveys, the study team adopted quantitative techniques. Besides descriptive analytics (e.g. means, particularly low or high scores on specific dimensions), interactions and correlations between key survey items were tested (inferential analytics/regression modelling, factor analysis, ANOVA). Statistically significant ones were used to give more insights into skills gaps, training provision in the steel sector as well as preferences and expectations for steel careers. Furthermore, the surveys were developed to offer advanced statistics, and especially inferential analytics to uncover factors influencing the key variables. Max-Diff offered insights into utility scores and enabled the study group to rank skills needs for both steel professionals as well as students, graduates and jobseekers. Conjoint analysis and CBC Hierarchical Bayes contributed to the assessment of students and jobseekers' individual preferences regarding careers in the steel sector. Given the size of the sample of students, graduates and jobseekers, hidden groups of stakeholders were investigated through latent class and clustering techniques. These are groups that are based on similar preferences/priorities and that consider certain aspects differently than other groups. These advanced components rely on mainstream marketing research techniques (quantitative modelling, clustering algorithms), which provide considerable empirical evidence on our findings (vs. ad-hoc analytics or often misleading basic statistics like means/medians).

The findings from the qualitative and quantitative data collected through desk research, interviews and surveys were presented in the study "European vision on steel-related skills of today and tomorrow" (published in August 2019[20]).

3.6. National workshops

In order to validate the findings and recommendations of the study as well as to gather more inputs on the seven target countries, national workshops were conducted in Finland, France, Germany, Italy, the Netherlands, Poland and Spain. The workshops brought together key stakeholders from national steel industries, i.e. representatives of steel companies, trade associations, workers' organisations, education providers and public authorities, in order to discuss current and future skills needs, to what extent the education and training programmes and practices address them as well as the image of the European steel industry and its competitiveness more broadly.

In each workshop, the participants provided feedback on study findings that were presented to them in a plenary session. They could also comment on communication materials that had been developed based on the study with the aim of increasing the attractiveness of careers in the steel sector. The second part of the workshop took the format of the World Café whereby several rounds of discussion took place in smaller groups, each group discussing one of four key themes (i.e. current and future skills needs, education and training, image, and competitiveness) and the participants changing place in regular intervals. The workshops concluded with a final plenary session summarising the main conclusions. The outcomes of the workshops were used to further develop national profiles of the steel industry in the seven target countries and to develop two implementation roadmaps that can be used to bridge skills gaps and increase the attractiveness of the European steel sector (see Annex 1: Implementation roadmap - Building the necessary skills for the EU steel industry and Annex 2: Implementation roadmap - Towards EU Education and Training on steel industrial technology skills).

3.7. Webinars

Two online webinars were carried out in order to validate the recommendations of the study and the related implementation roadmaps. The webinars brought together a

[20] European Commission, Blueprint for sectoral cooperation on skills. Towards an EU strategy addressing the skills needs of the steel sector: European vision on steel-related skills of today and tomorrow, Publication Office of the European Union, 2019

selection of stakeholders that had previously participated in national workshops, with the aim to facilitate an exchange between the seven target countries and the different stakeholder categories and link needs and best practices at national level with the European level.

In each webinar, a draft of one of the implementation roadmaps was presented, whereupon the participants were asked to provide detailed feedback, particularly in relation to feasibility and relevance of the proposed actions. Special attention was also given to the timeline and financing aspects. The implementations roadmaps were subsequently adjusted in line with the feedback collected. They are presented in this report in the sections 7.1 and 7.2 respectively.

4. RESEARCH OUTCOMES

This chapter provides a breakdown of the study findings. This includes a brief description of the changes and challenges that impacted the steel industry in the last years, an assessment of the present and future in-demand skills, and an overview of the actions undertaken to promote skills development in the sector.

4.1. The evolution of the European steel industry

The European steel industry, which laid the foundations for the creation of the EU, still plays a crucial role in terms of progress, economic growth and job opportunities[21]. After China, Europe is the second largest producer of steel at global level with an output of about 160 million tonnes a year[22], accounting for approximately 10% of production[23], and a turnover of EUR 170 billion a year[24]. This reflects on the industry's contribution to the EU's exports (over half of them come from steel), the labour market (according to EUROFER's estimations, there are about 500 production sites in 24 different Member States employing over 320,000 workers and creating about 1.6 million indirect jobs in the EU)[25] and several downstream industries, notably automotive, construction and infrastructure, robotics, advanced machinery and tooling, and home appliances.

The European steel industry has been subject to significant changes over the past century. For a large part of the 19th and the 20th century, the industry was deeply rooted in the development trends of the manufacturing sector. With the establishment of the ECSC, which was the forerunner of the subsequent treaties underpinning the modern EU, the iron and steel industry began a clustering process that led to an intensification of the relationships among companies operating in the European area[26].

The emergence of major steel-producing multi-nationals and the progressive deregulation of the industry between the 1980s and the 1990s pushed the European steel industry to become an internationalised industry with a strong regional focus. According to the OECD, "state ownership has declined rapidly until 2000s in the steel sector, mainly due to the proves of privatisation in Europe in the mid-1980s" (p.17)[27]. In 2016, state-enterprises represented 32% of global crude steel output. In Europe, the share of privately-owned steelworks skyrocketed from 46% to 92% between 1986 and 1995. A clear example of this phenomenon is provided in the Italian case (for additional details, see Annex 7.3.4 Italy). The country's steel production was largely dominated by State-owned steelworks during the great expansion of the 1950s and 1970s. By 1996, however, steelmaking was entirely privatised. Another case is constituted by the Polish industry, which was privatised following the fall of the communist regime.

International mergers and take-overs have become a widespread trend in Europe since the late 1990s. Nowadays, the largest part of steel production in the EU is mainly controlled by two multinational companies, ArcelorMittal and Tata Steel, followed by the German company thyssenkrupp.

The restructuring of the industry, together with increasing levels of overproduction and imports from emerging markets, led to a steep decline in employment and large-scale cuts in the workforce. As Table 2 shows, total direct employment in the European steel industry fell from 996,000 positions in 1974 to 278,000 in 2000. Particularly large cuts occurred

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[21] European Commission, The future of European steel. Innovation and sustainability in a competitive world and EU circular economy, Luxembourg: Publications Office of the European Union, 2017

[22] European Commission, European Steel - The Wind of Change: Energy in Future Steelmaking; Steel in the Energy Market Applications; Greening European Steel, Luxembourg: Publications Office of the European Union, 2018

[23] OECD, Steel Market Developments: Q4 2017, OECD Publishing, Paris 2018, p. 41

[24] European Commission, 2017, op.cit.

[25] EUROFER, European Steel in Figures 2019, 2019, p.7

[26] Fairbrother P., Stroud D. and Coffey A., "The European Union Steel Industry: From a National to a Regional Industry", Cardiff University - School of Social Sciences, Working Paper Series 54, 2004, p.4

[27] OECD, State enterprises in the steel sector, DSTI/SC(2017)10/FINAL, 20 December 2018

between 1980 and 1990, when the industry experienced a decrease of over 39% in total direct employment in just one decade[28] (with consequences on the current status of the workforce, characterised by a substantial age gap between older workers and new hires).

Table 2 — Employment in the European steel industry between 1974 and 2000[29]

Country	Employment, '000s		2000 as percentage of 1974
	1974	2000	
Austria	44	12	27
Belgium	64	20	31
Denmark	2	1	50
Finland	12	8	66
France	158	37	23
Germany	232	77	33
Greece	0	2	-
Ireland	1	0	-
Italy	96	39	40
Luxembourg	23	4	17
Netherlands	25	12	48
Portugal	4	2	50
Spain	89	22	24
Sweden	50	13	26
UK	194	29	14
TOTAL	**996**	**278**	**28**

An even more substantial decrease in jobs was registered in central and eastern European countries such as Czech Republic and Poland, which underwent a substantial restructuring process starting in the 1990s and until the early 2000s. In 1993, to limit further increases in overproduction and improve the efficiency of the European steel market, central and eastern European countries followed the obligations laid down by the European Steel Aid Code, thus limiting state aid, and reduced their production capacity, while also adopting new technologies. Privatisation and restructuring led to the modernisation of steel mills and their increased competitiveness, but employment losses could not be prevented. Between 1990 and 2006, the Polish steel workforce downsized from 147,000 to 30,388 workers, and Czech Republic from 93,000 to 25,914 workers. Similar conditions also applied to Romania, where in the same period, employment fell by over 60%[30].

In addition to recurring overcapacity and an increasingly high sensitivity to dumping pressure, the European steel industry suffered deeply from the effects of the 2008 financial and economic crisis. Steel-consuming industries were among those that were hit the hardest. In 2009, production levels fell by 40% and 10% in automotive and construction respectively. As a consequence, European steel demand shrunk considerably. After a steady growth between 2002 and 2007, crude steel production fell by 34% in 2009 (under

[28] Fairbrother P., Stroud D. and Coffey A., "The European Union Steel Industry: From a National to a Regional Industry", Cardiff University - School of Social Sciences, Working Paper Series 54, 2004, p.17
[29] Ibid., p.15
30 Trappmann, V., "Steel in the European Union in the wake of the global economic crisis", in Galgóczi, B., Drahokoupil, J. Bernaciak, M. (eds.), Foreign investment in eastern and southern Europe after 2008. Still a lever of growth?, ETUI: Brussels, 2015, pp.355 - 375

150 million tonnes)[31]. Despite a mild improvement in 2010, steel production never recovered entirely, staying barely above 150 million tonnes. According to World Steel Association, crude steel production in the EU was 154.9 million tonnes in 2017[32] and decreased of about 4% between 2018 and 2019[33]. The latest figures, published in April 2020, indicate a decrease of 10% in the crude steel production in the EU for the first three months of the year compared to 2019[34]. European steelmaking's position in the global arena is still rather uncertain, as shown by the negative market shift of the recent months, and, overall, European demand is unlikely to recover to pre-crisis levels.

Low production went hand in hand with site closures and employment cuts. In the aftermath of the crisis, the steel industry lost 9.2% of its jobs (as Figure 2 shows). Between the start of the crises and 2013, 40,000 jobs were lost, according to the European Commission's "Action Plan for a competitive and sustainable steel industry in Europe"[35]. In the long term, the industry experienced a contraction in employment of about 78,000 jobs.

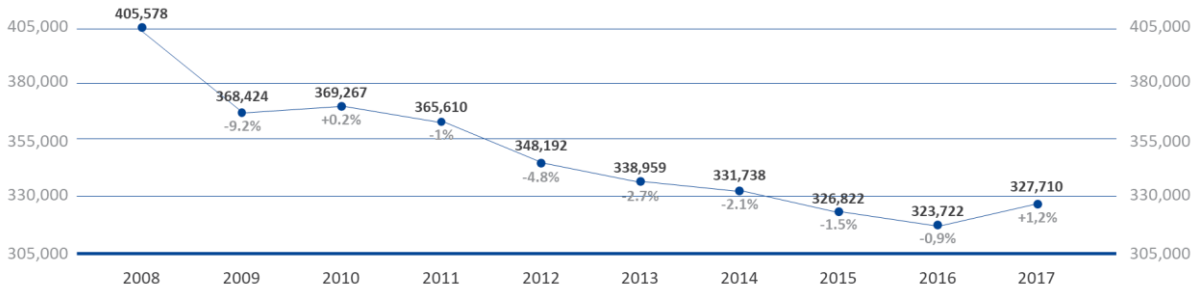

Figure 2 — Employment in the European steel industry between 2008 and 2017[36]

Despite the truly European character of the industry, recovery has been uneven among Member States. Each country presents dissimilarities in terms of the energy market and available funding. Austria, Germany, the Netherlands, Poland, and Slovakia have overcome the crisis, reaching again or surpassing the pre-crisis output. However, Belgium, Finland, France, Italy, Spain, and Sweden are experiencing a slower recovery, while the Czech Republic, Romania and the UK have not recovered at all[37].

Furthermore, during 2020, the COVID-19 pandemic caused major disruption to the sector, the implications of which are yet to be fully understood. Although differences exist between countries and also within the same country, the pandemic has led to governments' decision to stop unnecessary production, leading to the partial or total shutdown of steel plants, significant capacity idling, drastic reduction in production and sales of downstream industries (automobile, construction, packaging, etc.) and thousands of layoffs. Steel demand and orders have already dropped significantly since the outbreak of the pandemic and a substantial recovery in demand is not expected in the forthcoming quarters, even after the removal of lockdown measures. Among others, ArcelorMittal anticipates a 30% decline in its steel deliveries. In France, the group decided to shut down one of the blast

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[31] Egenhofer, C. et al, The steel industry in the European Union: Composition and drivers of energy prices and costs, Centre for European Policy Studies, Brussels, 2013, p.14

[32] World Steel, November 2017 crude steel production, World Steel Association, Brussels, 20.12.2017, https://www.worldsteel.org/media-centre/press-releases/2017/november-2017-crude-steel-production.html, Last visited on 07.05.2020

[33] World Steel, November 2019 crude steel production, World Steel Association, Brussels, 20.12.2019, https://www.worldsteel.org/media-centre/press-releases/2019/November-2019-crude-steel-production.html, Last visited on 07.05.2020

[34] World Steel, March 2020 crude steel production, World Steel Association, Brussels, 22.12.2019, https://www.worldsteel.org/media-centre/press-releases/2020/March-2020-crude-steel-production.html, Last visited on 07.05.2020

[35] European Commission, "Action Plan for a Competitive and Sustainable Steel Industry in Europe", COM(2013) 407 final, European Commission, Brussels, 11.06.2013

[36] EUROFER, European Steel in Figures 2018, 2018, p.9

[37] European Commission, The future of European steel. Innovation and sustainability in a competitive world and EU circular economy, Luxembourg: Publications Office of the European Union, 2017

furnaces at Fos-sur-Mer. It also mothballed another blast furnace and a converter at Dunkerque and announced the shutdown of the coking plant at Florange[38].

The current pandemic has led to additional concerns as China, which has eased the confinement since April 2020, may now sell its stocks on the world market at lower prices and with shorter deadlines[39]. The evolution of the situation and the consequences of the crisis on the steel sector remain to be assessed. Nonetheless, it should be noted that in the last decade, the European steel industry has been faced with additional competitive pressure due to the emergence of new players in the international steel market. The industrialisation of China and India as well as the use of shale gas by some countries to reduce energy costs of steel production have intensified competition in the production and trade of steel[40]. Between 2007 and 2017, China's share in global steel production increased by approximately 13%, while the EU's fell by 5% (see Figure 3).

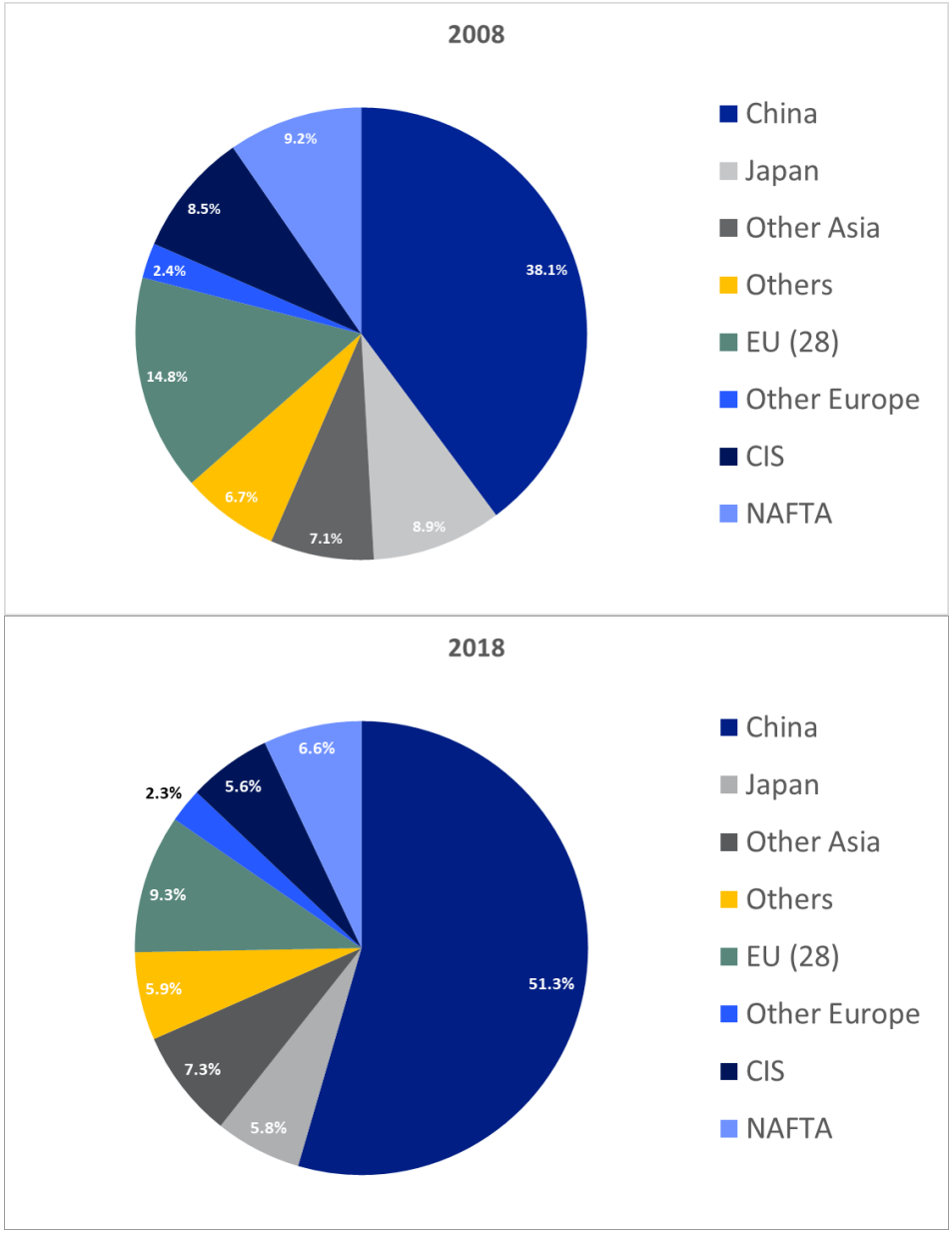

Figure 3 — Global crude steel production: Geographic distribution 2008 - 2018[41]

[38] 'L'acier européen en mauvaise posture', *Le Figaro*, 08.5.2020, p.32
[39] Ibid.
[40] European Commission, 11.06.2013, op. cit.
[41] World Steel, World steel in Figures 2019, World Steel Association, Brussels, 2019

External competition has also increased prices of raw materials, thus raising production costs for European steel producers. For instance, a tenfold increase in the price of iron ore was recorded between 2001 and 2011[42]. Coking coal and electricity prices also increased, the latter by about 8% between 2005 and 2012.
Regulatory costs (such as those borne for compliance with environmental protection legislation or investments in environmental protection triggered by legislation) may contribute to further affecting the competitiveness of the industry, especially in times of crisis, when they may be higher than the EBITDA, and normally fall between 20%-30% of the EBITDA. According to the 'Assessment of cumulative cost impact for the steel industry' performed by the Centre for European Policy Studies and Economisti Associati, in 2012, Blast Oxygen Furnace (BOF) producers faced regulatory costs at about 7.7-9.7 EUR/tonne of finished product, while regulatory costs for Electric Arc Furnace (EAF) producers amounted to 14.2 EUR/tonne of finished product.[43] Whilst this makes non-European steel more convenient for purchasers, it results in consistent investments by the industry to develop, test, adapt and adopt breakthrough technologies for ultra-low carbon steelmaking.

The situation has been worsened by discriminatory and imbalanced practices, such as trade restrictions in the form of tariffs and non-tariff measures, dumping and other unfair price practices (e.g. duties on the imports of raw materials, excessive licensing requirements, et al). To tackle these issues, the EU has adopted trade defence measures to offset the impact of dumping on the European steel industry (amounting to 47 anti-dumping and anti-subsidy measures in 2017 as well as provisional safeguard measures on a number of steel imports, to address the US tariffs on European steel[44] and several measures concerning imports from China[45]). Between 2014 and 2019, the Commission imposed 25 new Trade Defence Instruments measures on steel and, for the first time since 2002, it initiated a safeguard investigation into steel products[46]. In addition, the Commission has organised discussions with WTO and OECD as well as Steel Contact Group meetings with relevant countries (i.e. China, India, Japan, Russia, Turkey and the US) to tackle the issue of overcapacity at global level[47].

Global excess capacity continues to pose a serious threat to the European steel industry, with over-production saturating the steel market because of mismatches between production and demand, and therefore causing a decrease in the price of steel[48]. To address this challenge, a Global Forum on Steel Excess Capacity was established in 2016 by the G20 Leaders. It brings together all G20 members and interested OECD members, for a total of 32 member economies, and gives members the chance to exchange data on subsidies and capacities, propose and decide on policy solutions, such as steps to rid the

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[42] European Commission, "Action Plan for a Competitive and Sustainable Steel Industry in Europe", COM(2013) 407 final, European Commission, Brussels, 11.06.2013

[43] Centre for European Policy Studies, and Economisti Associati, Assessment of cumulative cost impact for the steel industry, Brussels, 2013

[44] European Commission - Press Release - "Trade: Commission Imposes Provisional Safeguard Measures on Imports of Steel Products", 18.07.2018, http://europa.eu/rapid/press-release_IP-18-4563_en.htm, Last visited on 22.05.2019

[45] European Commission, "Steel: Preserving sustainable jobs and growth in Europe", COM(2016) 155 final, European Commission, Brussels, 16.03.2016

According to a later report (European Commission, The future of European steel. Innovation and sustainability in a competitive world and EU circular economy, Luxembourg: Publications Office of the European Union, 2017), the Commission imposed duties ranging between 65.1% and 73.7% for heavy plates and 13.2% and 22.6% for hot-rolled steel to Chinese steel products.

[46] European Commission, "Report from the Commission to the European Parliament and the council - 37th Annual Report from the Commission to the Council and the European Parliament on the EU's Anti-Dumping, Anti-Subsidy and Safeguard activities and the Use of trade defence instruments by Third Countries targeting the EU in 2018", COM(2019) 158 final, European Commission, Brussels, 27.03.2019

[47] European Commission, "Steel: Preserving sustainable jobs and growth in Europe", COM(2016) 155 final, European Commission, Brussels, 16.03.2016

[48] European Commission - Press Release - "Steel: European Commission Welcomes Ambitious Global Forum Agreement to Tackle Overcapacity", 30.11.2017, https://ec.europa.eu/commission/commissioners/2014-2019/malmstrom/announcements/steel-european-commission-welcomes-ambitious-global-forum-agreement-tackle-overcapacity_en, Last visited on 22.05.2019

market of distorting subsidies and strengthening the role of the market[49]. Against the backdrop of these initiatives, however, global overcapacity still makes up for the underlying factor behind the crises impacting the European steel market. As EUROFER points out, 2018 has been marked with a sudden negative shift in the prospects of the European steel industry, with imports rising by 12% to nearly 30 million tonnes following the imposition of the US Section 232 steel tariffs[50]. In October 2019, the European Commission welcomed the continuation of the work of the Global Forum on Steel Excess Capacity with the intention to keep defending the European industry from distortions in the steel market through multilateralism and cooperation[51].

4.1.1. Measures to innovate the industry

Despite its recurring crises, today the European steel industry stands out as a world leader in the manufacturing of highly specialised product segments and in the implementation of cutting-edge production technologies[52]. Rather than competing on price with larger non-EU producers, European companies regard investments in Research & Development & innovation (R&D&I) as strategic, since these allow to achieve cutting-edge technological breakthroughs, as well as high value added products and solutions[53]. Steelmaking is sensitive to technological changes, and game-changing trends such as automation, Big Data and Industry 4.0 are expected to play a major role in the sector's evolution. Furthermore, the challenges of sustainability and CO_2 reduction open up a wide range of opportunities for companies willing to invest in innovation.

To enable European steel companies to maintain their competitive edge, EU policymaking plays a crucial role. As indicated in the Communication "A new industrial strategy for Europe"[54], the European Commission strives to support a globally competitive, green and digital Europe, fostering innovation, sustainability and skilling and reskilling. With regard to innovation, new Public Private Partnerships will be established in the Horizon Europe programme and new approaches to innovation will be tested. This would allow the industry to pursue novel solutions to remain competitive, while reducing CO_2 emissions. The Commission will also support the creation of new markets for climate neutral and circular products, including steel, as well as clean steel breakthrough technologies for zero-carbon steelmaking, launching the EU Strategy on Clean Steel. The EU Emissions Trading System Innovation Fund will provide further help for clean products in all energy-intensive sectors. A new "Pact for Skills" will be promoted to unlock public and private investment in the workforce and an update of the Skills Agenda for Europe is foreseen in 2030. In March 2020, the EU Gender Strategy was adopted and will be implemented, aiming to encourage women to study STEM subjects. Additionally, EU policymaking is expected to contribute to reinforcing Europe's industrial and strategic autonomy, which means reducing dependence on non-EU parties for critical materials and technologies. Therefore, the EU will support the development of key enabling technologies (e.g. robotics, high performance computing, advanced materials and technologies, etc.) and the creation of an Action Plan on Critical Raw Materials to improve access to raw materials. The Commission will undertake a thorough screening and analysis of industrial needs and identify ecosystems needing a tailor-made approach. To support this work, the setup of an Industrial Forum is foreseen by September 2020. Furthermore, the EU will leverage its trade defence mechanisms to

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[49] Ibid.

[50] EUROFER - Press release - "European steel industry calls on policymakers to end steel crisis and to save hundreds of thousands of jobs", 24.05.2019, http://www.eurofer.org/News%26Events/Press%20releases/PRESS%20RELEASE%20%20European%20steel%20industry%20c.fhtml, Last accessed on 03.06.2019

[51] European Commission, European Commission welcomes continuation of Global Forum on Steel Excess Capacity work, Brussels, 29.10.2019, https://trade.ec.europa.eu/doclib/press/index.cfm?id=2077, Last visited on 07.05.2020

[52] European Commission, "Steel: Preserving sustainable jobs and growth in Europe", COM(2016) 155 final, European Commission, Brussels, 16.03.2016

[53] European Commission - Directorate-General for Enterprises and Industry, Study on the Competitiveness of the European Steel Sector - Final report, August 2008, Ecorys SCS Group, Rotterdam, 2008

[54] European Commission, "A new industrial strategy for Europe", COM(2020) 102 final, European Commission, Brussels, 10.03.2020

secure a free and fair international trade system and counter market distortions (e.g. government subsidies)[55].

According to the aforementioned Communication, "Europe's industry has a global competitive advantage on high value-added products and services. It leads by example complying with the highest social, labour and environmental standards"[56] and its innovation capacity has made Europe acquire a leading position in green technology patents and high tech sectors. For the steel sector, further enhancing innovation and investment in research is paramount to meet the energy, climate and resource efficiency goals set by the EU, while ensuring competitiveness and job creation[57]. The emission-reduction potential of the industry was around 10% in 2013 with little room for improvement as the most efficient plants were reaching their physical limit[58]. New production processes, equipment, materials, products and applications must be developed to create a smart, clean and competitive industry. To achieve this, synergies should be sought with other industries (paper, ceramics, copper, etc.) to enhance the utilisation of by-products[59] and to diversify, when possible, the supply routes for the industry. More importantly, innovation in steelmaking should be pursued by incorporating principles such as circular economy, and combined with developments in the energy sector, as common policies and investments are needed.

Clearly, innovation means building upon current technological advancements. For instance, Big Data and integrated intelligent manufacturing (I2M) hold potential to innovate work at steel plants. Possible applications of Artificial Intelligence (AI) to process modelling and optimisation are currently being explored to increase energy efficiency (e.g. project DYNERGYSTEEL, aiming to develop tools for the dynamic optimisation of access to the electricity market)[60]. To make steel production less energy intensive and more environmentally friendly, novel methodological approaches and tools are tested to foster a better management of resources to reduce waste materials, improve recycling and limit the intake of new resources (see, in this case, the project REFFIPLANT[61]).

In parallel, European steel companies are involved in the development of new technological approaches to reduce CO_2 emissions. This goal is pursued through two main pathways: Smart Carbon Usage (SCU) and Carbon Direct Avoidance (CDA).

- **SCU** is an approach that requires capturing the emitted CO_2 and using it as raw material in other chemical/industrial processes. At first, attempts were made to store the CO_2 underground for future usage (Carbon Capture and Storage — CCS) but this proved to be impossible. Nowadays, the SCU pathway includes two overarching groups of initiatives: Process integration, which defines all actions aimed at modifying all steelmaking processes based on fossil fuels to help reduce the use of carbon; and Carbon Capture and Usage (CCU), which implies the direct usage of CO_2 in chemical/industrial processes. Several projects are being

[55] Ibid.
[56] European Commission, "A new industrial strategy for Europe", COM(2020) 102 final, European Commission, Brussels, 10.03.2020, p.2
[57] European Commission, "A new industrial strategy for Europe", COM(2020) 102 final, European Commission, Brussels, 10.03.2020
[58] European Commission, High-level Round Table on the future of the European Steel Industry. Recommendations, 12.02.2013
[59] An example is the production of steelanol, that is synthetic ethanol generated from waste gases that are produced during the steelmaking process. See: European Commission, The future of European steel. Innovation and sustainability in a competitive world and EU circular economy, Luxembourg: Publications Office of the European Union, 2017, p. 22
[60] Other relevant initiatives aimed to improve energy efficiency are: (a) the projects GASNET and EnergyDB – see European Commission, The future of European steel. Innovation and sustainability in a competitive world and EU circular economy, Luxembourg: Publications Office of the European Union, 2017; (b) ULCOS, the ultra-low carbon dioxide steelmaking project that will run until 2020 – see European Commission, "Steel: Preserving sustainable jobs and growth in Europe", COM(2016) 155 final, European Commission, Brussels, 16.03.2016
[61] See: http://reffiplant.com/, Last visited on 16.05.2019

implemented to explore SCU, such as HIsarna[62], IGAR[63], and STEPWISE[64] (Process Integration), Steelanol[65], Carbon2Chem[66] and FReSME[67] for CCU

- **CDA** aims at completely removing carbon from steelmaking processes by using hydrogen produced from renewables or renewable electricity in direct reduction, plasma smelting reduction or electrolysis processes. "A large number of new process route concepts are being investigated in the EU"[68] (e.g. HYBRIT[69], GrInHy[70], H2Future[71], SALCOS[72], SIDERWIN[73], etc.)

CO_2 reduction projects at various Technical Readiness Levels (TRL) are being pursued by the major European companies, including ArcelorMittal, Tata Steel Europe, thyssenkrupp, Salzgitter, Voestalpine, etc. However, it will take financing worth about EUR 10 billion and a timeline of 10 to 15 years to build industrial-scale demonstrators and make their market roll-out feasible[74].

One of the solutions to reduce CO_2 is to recycle steel and produce it from scrap steel. This is known as the secondary production route, and relies on the use of Electric Arc Furnaces (EAF)[75]. The use of scrap steel is encouraged to mitigate negative impacts on climate, as it requires less energy to produce, and has the advantage of relying less on the import of raw materials. It should be noted that secondary steel production covers about 40% of the steelmaking market. Also, secondary scrap steel is not expected to reach sufficient levels to meet the needs of steel consumption for decades[76].

Another industry-led initiative which tackles these challenges is the Steel Construction Products Mark, named SustSteel[77], a label which guarantees and promotes the sustainability of steel products. This initiative encourages companies to produce steel in more sustainable ways, to reduce energy consumption and CO_2 emissions. Similarly, the research and development project SuSteel (sustainable steel) strives for a CO_2 free production of crude steel using hydrogen plasma[78].

Although some breakthrough alternatives have been developed already, they still have to be piloted and de-risked, increasing their potential for wider uptake and replication. Adapting them to existing industrial settings requires substantial investments that not all companies are ready to make. Several funding possibilities have been set in place by the European Commission to support ambitious projects that may facilitate the transition to a renovated industry, including[79,80]:

- Horizon 2020 Programme, especially the SPIRE Public-Private Partnership;
- European Structural and Investment Fund (ESIF);
- Research Fund for Coal and Steel (RFCS);

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[62] See: https://www.Tatasteeleurope.com/en/innovation/hisarna/about-hisarna, Last visited on 16.05.2019
[63] See: https://www.ademe.fr/igar, Last visited on 16.05.2019
[64] See: https://www.stepwise.eu/, Last visited on 16.05.2019
[65] See: http://www.steelanol.eu/en, Last visited on 16.05.2019
[66] See: https://www.thyssenkrupp.com/en/carbon2chem/, Last visited on 16.05.2019
[67] See: http://www.fresme.eu/, Last visited on 16.05.2019
[68] EUROFER, Discussion Paper - Towards an EU masterplan for a Low-Carbon, Competitive European Steel Value Chain, Final draft, Brussels, 2018
[69] See: http://www.hybritdevelopment.com/, Last visited on 16.05.2019
[70] See: https://www.green-industrial-hydrogen.com/, Last visited on 16.05.2019
[71] See: https://www.h2future-project.eu/, Last visited on 16.05.2019
[72] See: https://salcos.salzgitter-ag.com/en/index.html?no_cache=1, Last visited on 16.05.2019
[73] See: https://www.siderwin-spire.eu/, Last visited on 16.05.2019
[74] EUROFER, 2018, op. cit.
[75] The primary production route relies on the production of steel from iron ore through Blast Furnaces and Basic Oxygen Furnaces (BF -BOF). It still accounts for about 60% of the European steelmaking market
[76] EUROFER, 2018, op. cit.
[77] See: See: https://www.steel-sustainability.org/esust/public/index, Last visited on 30.03.2020
[78] See: https://www.k1-met.com/en/research_programme/susteel/, Last visited on 09.05.2020
[79] European Commission, "Steel: Preserving sustainable jobs and growth in Europe", COM(2016) 155 final, European Commission, Brussels, 16.03.2016
[80] European Commission, The future of European steel. Innovation and sustainability in a competitive world and EU circular economy, Luxembourg: Publications Office of the European Union, 2017

- European Fund for Strategic Investments (including EIB loans for steel).

Besides the economic risk, taking up promising technologies is challenging as far as skills required are concerned. As the next chapters illustrate: steelmaking companies struggle finding candidates with the right skills. Firstly, the introduction of new technologies and automation is challenging for older workers who do not necessarily have the right skills to handle new machinery. Additionally, time-lags occur between the introduction of an innovation and the provision of suitable training, and companies do not always provide training in anticipation to skills gaps. At the same time, educational programmes do not necessarily correspond to the current needs of the industry and graduates do not match the expected professional profiles. Those who do are often unwilling to work in the industry, which is still perceived as a dirty, noisy and dangerous industry. Additionally, the industry has not developed widely used skills anticipation methods for recruitment, which creates knowledge transfer issues – the steel sector workforce is ageing and the number of retirements is expected to further increase.

Tackling the challenges indicated above, while also ensuring that workers benefit from decent social standards, requires boosting the sector's competitiveness in terms of innovation, quality and technology[81]. Because of this, highly skilled individuals who have the capacity to bring the industry forward through digitalisation, Industry 4.0 and sustainability are needed.

4.2. The image of careers in the steel sector

Although little literature exists on the image of the steel sector, available sources (European Commission's reports, interviews with stakeholders, surveys) suggest that the industry is comparatively less attractive for potential employees[82]. Based on the results of Survey 2, students, graduates and jobseekers tend to look for positions that give them task variety (81% agreement[83]) and good advancement opportunities (80% of respondents agree[84]), that allow them to contribute to societal goals (65% agreement[85]) and where they can participate in decision making (70% agreement[86]). Furthermore, they express a preference for clean and quiet working environments (67% agreement[87]). However, the overall negative image of the steel industry seems to clash with students', graduates' and jobseekers' expectations for a job. Steelmaking is perceived as a heavily polluting and energy-intensive activity. Steel-related careers are associated with physically demanding work, unhealthy, unsafe and/or unwelcoming work environments (noisy, dirty steelworks, high temperatures, shifts) and low-skilled positions[88]. Among survey respondents, 71%[89] regard work in the steel industry as manual/physical and only 24%[90] agree that working conditions in steel plants are generally good. In addition, 67%[91] agree that there is a high risk of work accidents in the steel sector. It is also noteworthy that only 39%[92] of respondents agree that working in the industry is a respected (prestigious) occupation.

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[81] European Commission, A Blueprint for Sectoral Cooperation on Skills (Wave II), Luxembourg: Publications Office of the European Union, 2018, p. 18
[82] European Commission, High-level Round Table on the future of the European Steel Industry. Recommendations, 12.02.2013
[83] 24% somewhat agree, 34.5% agree, 23% strongly agree.
[84] 21% somewhat agree, 30% agree and 30% strongly agree.
[85] 25% somewhat agree, 24% agree and 16% strongly agree.
[86] 26% somewhat agree, 27% agree and 18% strongly agree.
[87] 26% somewhat agree, 23% agree and 18% strongly agree.
[88] This is not so much the case with survey respondents: only 29% agree with the statement that most jobs in the steel sector are low skilled and only 16% agree that no qualifications are needed to work in the steel industry. However, this can be explained by the fact that the majority of the respondents has had a previous experience in the steel sector (86% of respondents have worked in the steel sector) and may therefore be more familiar with the actual requirements of the industry.
[89] 28% somewhat agree, 29% agree and 14% strongly agree.
[90] 14% somewhat agree, 7% agree and 3% strongly agree.
[91] 33% somewhat agree, 24% agree and 11% strongly agree.
[92] 23% somewhat agree, 13% agree and 4% strongly agree.

Consequently, graduates who may have the right skillset tend to turn to other industries that seem more accessible and rewarding.

Before analysing the image of steel careers, one should consider that the steel sector is largely influenced by the same factors that affect the manufacturing industry as a whole. For example, one of the major concerns raised by representatives of the industry and academia, irrespective of their country of origin, is the lack of students undertaking or graduating from STEM curricula. Despite recent increases in enrolments, the number of engineers and trained technicians is still considered too low to meet the needs of the manufacturing industry. Manufacturing has experienced a change of paradigm over the past thirty years. In the 1980s, the industry was a logical choice for many semi-skilled and highly skilled workers, who often lived local to a plant and followed past generations into the industry. However, after a long period of stagnation with hardly any new hires, the industry is now faced with the challenge of having to attract new talents. In doing so, it has to compete with other fast-growing economic segments such as the service sector, while at the same time challenging an overall negative image, which is heavily influenced by stereotypes and misconceptions[93].

It should be noted that despite the common trends that have been identified in the available sources, as well as in the answers provided by survey respondents and interviewees, the image of steel careers varies depending on the national and local context that is taken into account. Although, on average, steelmaking is affected by the same negative elements, its image seems to be better in Northern European countries such as Germany and the Netherlands, where the steel industry appears to guarantee students and young professionals a certain job stability. Overall, though, even in countries where the industry shows good health, such as Finland, students and young people still seem to prefer jobs in the service sector.

4.2.1. Perceptions and misconceptions around steelmaking

Traditionally, the steel industry was considered as a source of stable and secure jobs at all levels. Steel was a point of reference to find employment even for workers with lower levels of education, and it was not uncommon for families living in steel-producing areas to work in steel mills for entire generations. In the last decades, however, the image of European steelmaking changed dramatically. The severe cycles of unemployment with massive layoffs and repeated restructurings were given strong media coverage. As a result, its reputation as a reliable employer took a severe hit. Many union representatives interviewed in this study, pointed to the cyclical restructurings and mergers affecting European steel companies as the main factor impacting perceptions around the industry as a potential employer. In addition, high and increasing discrepancies between the wage level of managers and workers were also mentioned as another factor discouraging people from working in the industry. Concerns for future job security were also raised by many survey respondents as a factor influencing their choice to work in the industry.

Steelmaking processes are also becoming increasingly sensitive to technological changes. As a result, the profile of the workforce will evolve and require higher levels of education and training than ever before.

> "*(…) steelmaking cycles would not change over long periods of time. Hence, a trained individual specialising in a specific task was able to perform the same job for the greatest part of his/her professional life. However, things have changed now: mechanical equipment (electric furnaces, rolling mills) undergo constant innovations, which require operators to be capable to adapt quickly to new technologies and processes*"[94].

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[93] Interview notes - Education Providers, Director of a steel-related training programme and former ECSC official

[94] Interview notes - Education Providers, Director of a steel-related training and former ECSC official

This contributing factor drove the industry further away from its traditional image as a steady job provider for low-skilled labour. Even in the areas with stronger links to steel plants, jobs in steelmaking are no longer seen as an attractive career choice. Smaller steel companies are more affected by this compared to their multinational counterparts, as they have more difficulties in maintaining steady production levels. Furthermore, they can invest less in company strategies and in-firm training, having poorer long-term financial outlooks.

Younger generations seem to consider the steel sector as not being prestigious enough and therefore unsuitable for those who have a university degree. 29% of Survey 2 respondents agree with the statement that most jobs in the steel sector are low-skilled. The findings also suggest that salaries are perceived as being too low for the working conditions. Survey results show that the salary for operators and technicians is considered to be lower than the ones that are offered in other industries to a person with the same degree. In most national cases analysed in this study, however, the average salary in metallurgy has been found to be adequate to, if not higher than, the industry average. Additionally, the industry is characterised by a stronger-than-average union representation, with an increased awareness of workers' rights and a strong attention to working conditions (although participative arrangements differ substantially from country to country).

Nonetheless, the negative perception of working conditions represents another challenging aspect preventing people from wanting to work in the steel sector. Along with perceived low salaries, expert interviews suggest that other factors discouraging people from seeking a job in the industry are related to the organisation of work in shifts, which appears to be particularly unpopular among jobseekers[95]. This is further exacerbated by the remote location of steelworks. The latter was considered to be particularly relevant by interviewees from Northern European countries (i.e. Finland and Sweden), which are characterised by low population density levels. In addition, steel plants are often considered as dirty, high-temperature work environments, where workers are exposed to health hazards and work-related incidents (many workers still suffer from the consequences of asbestos exposure in the 1970-1990 period). Most steel companies have undertaken substantial efforts to modernise their infrastructure, with a strong focus on occupational safety. According to World Steel's safety data, the steel industry has seen a steady reduction of the Lost Time Injury Frequency Rate (LTIFR)[96] over the past 10 years[97]. However, there is still a widespread misconception that working in a steel plant is "like going down the pits"[98]. This is at odds with reality, declares Nicholas Walters, Director of Communications and Public Policy at World Steel: "Many modern steel plants are state-of-the-art facilities using cutting-edge technology. These days, working in a steel plant is more like working in either a laboratory or control room"[99]. Steel plants work with high degree of automation, with little to no direct contact with the cast product. In general, women respondents tend to point out that the industry is not suitable for female workers: despite being interested in working in the sector, they feel that steelworks do not provide the necessary infrastructure for women to be able to work and that the working environment is hostile.

Findings suggest that another key issue affecting the image of the steel industry is environmental sustainability. According to several survey respondents, steelmaking is considered a polluting and unhealthy industry. This negative image is probably reinforced by recent events involving steel plants around Europe, which were heavily portrayed in the media. The most representative case is that of ILVA Taranto, the largest European

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[95] When asked under which condition they would work in the steel industry, the majority of survey respondents said that they would prefer part-time or full-time positions with a good work--life balance, and specified that they were not available to work shifts.

[96] A Lost Time Injury (LTI) is an incident that causes an injury that prevents the person from returning to his next scheduled shift or work period. Lost Time Injury Frequency Rate (LTIFR) is the number of Lost Time Injuries per million man-hours. LTIFR includes fatalities

[97] World Steel, Safety and Health in the Steel Industry - worldsteel position paper, 2017

[98] "Reputation Enhancement - Does Steel Have a Cast Iron Reputation?", Steel Times International, Issue July/August 2015

[99] Ibid.

steelwork located in Southern Italy, now part of the ArcelorMittal group. Despite accounting for about three quarters of Taranto's economic output, interviewees who have worked in the area admitted that the continuous issues related to the plant's environmental impact have deeply deteriorated its relationship with the residents (the plant's activities were directly linked with water and air pollution, as well as a high number of hospitalisations for respiratory illness)[100]. According to local trade union representatives, this is particularly true for young people, who are reluctant to make a career there[101].

Being an energy-intensive industry, steelmaking still produces considerable amounts of CO_2. Reducing the industry's environmental footprint is at the core of the Commission's 2013 Steel Action Plan[102] and new industrial strategy[103]. Several R&D&I initiatives are being funded to achieve this goal (see Chapter 4.1). Despite this objective challenge, many interviewees from industry and academia note that steel remains one of the most durable and versatile materials available. Steel products have very long lifespans, and they can be transformed and reused in steelmaking processes several times. According to Tata Steel Europe, on average, around 85% of steel is recycled and re-used, over 99% of steel from scrap cars is recycled, 99% of structural steel can be reused when a building is demolished, and 70% of steel packaging in Europe is recycled[104].

> *"People fail to see the science that is involved in the production of steel. Steel is 100% recyclable and opens many possibilities to students and professionals interested in the themes of decarbonisation and sustainable energy production"*[105].

To overcome the negative environmental image affecting the industry, steel producers need to highlight the overall benefits of steel-made products and communicate more effectively how complex and challenging steelmaking can be. Moreover, steel companies should showcase their efforts towards environmental sustainability and decarbonisation. Over half of the respondents (53.5%) in the survey for students, graduates and jobseekers agree that steel companies make efforts to improve sustainability, 27% neither agree nor disagree and a smaller proportion (20%) disagrees. This may be explained by the fact that 86% of the respondents claimed to have already worked in the steel sector[106]. Thus, they might have first-hand experience of the company's efforts towards sustainability, something that is not necessarily the case for the general public. In addition, it is key to provide the general public with a clear visualisation of the relevance of steel products in everyday life as well as the strong reliance that most industrial sectors have on steel. According to Nicholas Walters, Director of Communications and Public Policy at World Steel, the industry should work harder to promote steel as a vital material. "This is particularly true in the context of steel's position in the circular economy, which demands zero waste, reducing the amount of materials used and encouraging the re-use and recycling of all materials – all key strengths of the steel industry"[107]. Rather than a commodity, steel should be promoted as a highly versatile product, which plays a vital role in society as a whole and is at the forefront of cutting-edge innovations and technological advancements towards an energy-efficient industry.

When asked about what factors would encourage them to work in the steel industry, some students and jobseekers that took part in the survey on the attractiveness of steel careers

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[100] Interview notes - Workers' Organisations, Senior representative at FIOM CGIL Taranto
[101] Interview notes - Workers' Organisations, Senior representative at FIOM CGIL Taranto
[102] European Commission, "Action Plan for a Competitive and Sustainable Steel Industry in Europe", COM(2013) 407 final, European Commission, Brussels, 11.06.2013
[103] European Commission, "A new industrial strategy for Europe", COM(2020) 102 final, European Commission, Brussels, 10.03.2020
[104] See: https://www.Tatasteeleurope.com/en/sustainability/steel-for-a-sustainable-future/the-life-cycle-of-steel, Last visited on 15.05.2019
[105] Interview notes - Industry Stakeholders, Representative of a national steel producers' organisation
[106] This may include students who carried out a summer job or a traineeship in the industry as well as jobseekers who were previously employed by the industry.
[107] "Reputation Enhancement - Does Steel Have a Cast Iron Reputation?", Steel Times International, Issue July/August 2015

admitted having little to no knowledge or information about the sector. Therefore, they were not able to determine what could make it attractive for them. A number of respondents expressed the willingness to learn more about the industry through an apprenticeship or a visit to a steel plant, indicating the need for companies to do more promotion at schools and universities. This finding suggests that the industry appears not to be known well enough, and that much more should be done to promote the prominence of steelmaking in modern societies.

According to the High-Level Round Table on the future of the European steel industry, set up in July 2012 by the Vice-President of the European Commission, Antonio Tajani, and the Commissioner for Employment and Social Affairs, László Andor, the best way to attract workers to the steel industry would be to promote quality and stable jobs[108]. Moreover, unused capacity could be tackled by giving special attention to high-grade speciality steels for sectors such as aerospace, offshore renewables and nuclear[109].

4.2.2. Students, graduates and jobseekers' willingness to work in the steel sector

Among the respondent group of students and graduates, several respondents indicated their interest in ICT, and declared that they would be willing to enter the steel industry if offered a position in ICT. Others indicated their preference for R&D functions, while others said that they would consider working in the steel sector in non-technical positions, such as marketing or HR. The conjoint analysis of the survey for students, graduates and jobseekers provided additional empirical indications of what younger generations would look for in a position if they imagined selecting a new job in the steel sector. Survey respondents were asked to choose consecutively among different possible job profiles (CBC analysis), which had six features with three or more attributes each, namely:

- Type of contract:
  - Full time – Permanent
  - Full time – Temporary
  - Part time – Permanent
  - Part time – Temporary

- Type of employer:
  - Self-employed
  - SME
  - National company
  - Multinational corporation
  - Public sector

- Type of work:
  - Sedentary work (office job)
  - Physically active work
  - A mix of sedentary and physically active work

- Remuneration:
  - Basic salary
  - Basic salary + bonus
  - Commission-based

[108] European Commission, High-level Round Table on the future of the European Steel Industry. Recommendations, 12.02.2013, p. 22
[109] Ibid., p. 4

- Benefits:
    - Skills training and continuous learning
    - Additional health insurance
    - Company amenities (e.g. car, phone, laptop)
    - None

- Place of work:
    - Centrally located
    - In an industrial area
    - Outside the city

The figure below shows the comparative importance (partworth/utilities) of the features based on the results of the conjoint analysis. The results suggest that students, graduates and jobseekers place more importance to the type of contract and the type of work. Moderate importance is attributed to the remuneration and the benefits, while the type of employer and the place of work seem to have an even lower importance.

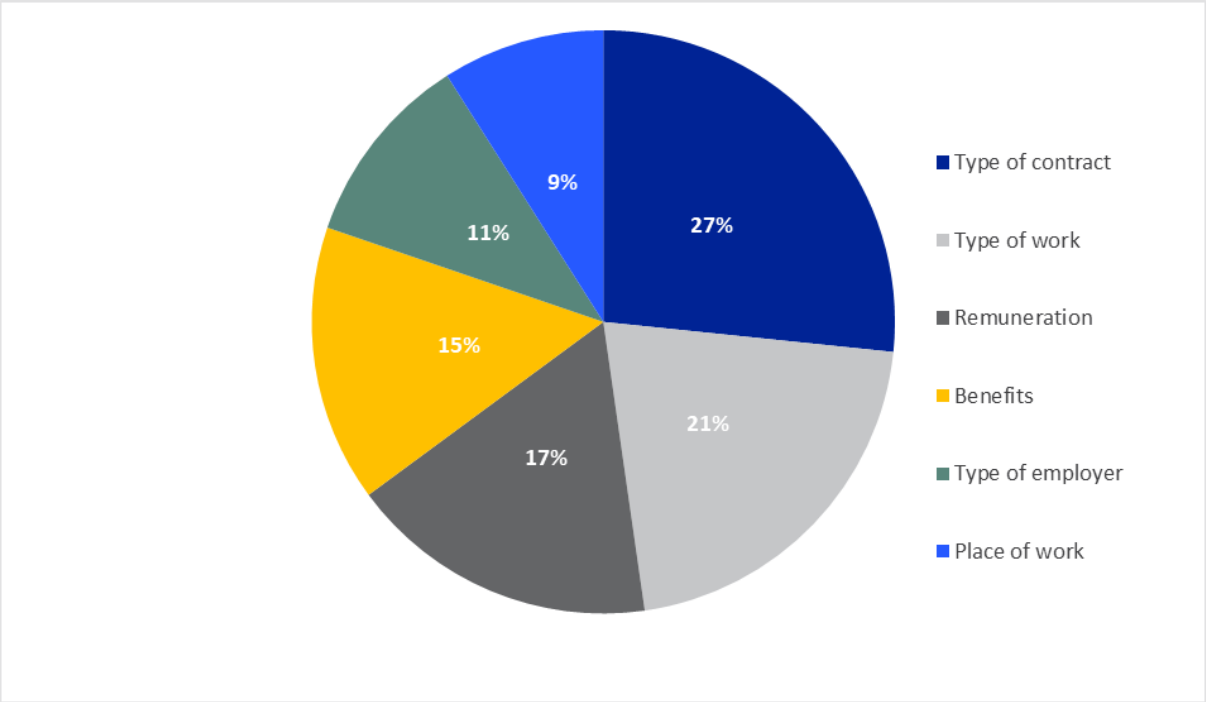

Figure 4 — Aggregated results from the conjoint analysis

It is important to go beyond this general picture and look at the different attributes within each feature to better understand the actual preferences. The table below shows the average utilities for each option (utilities are zero-centred[110]). Positive values indicate a preference, while negative values indicate a dislike towards a certain option. The higher the value, the greater the preference (or dislike) towards an option. With a relatively simple overview, it is possible to establish the relative importance of each option (when comparing the individual average utility with the percentage breakdown of the importance of feature at aggregated level). A visual illustration of the results is provided in Figure 5.

[110] The sum of the average utilities of the options for each feature is zero.

Table 3 — Average utilities per attribute

Feature	Attribute	Average utility
Type of contract	Full time - Permanent	44.76498
	Full time - Temporary	-2.02524
	Part time - Permanent	2.83286
	Part time - Temporary	-45.57261
Type of employer	Self-employed	-5.40773
	SME	-8.57731
	National company	1.27363
	Multinational corporation	15.20359
	Public sector	-2.49217
Type of work	Sedentary work (office job)	15.59930
	Physically active work	-39.93254
	A mix of sedentary and physically active work	24.33324
Remuneration	Basic salary	-5.20453
	Basic salary + bonus	45.63154
	Commission-based	-40.42701
Benefits	Skills training and continuous learning	12.47872
	Additional health insurance	2.97735
	Company amenities (e.g. car, phone, laptop)	24.50159
	None	-39.95766
Place of work	Centrally located	13.70874
	In an industrial area	-7.27492
	Outside the city	-6.43382

In terms of contract, respondents clearly prefer to have a permanent full-time position, and strongly dislike a part time, temporary position. This is in line with other findings highlighting the importance of a stable, secure position. Stressing the security of careers in the steel sector or showing how the risk of shutdown is minimised would be an important element to attract new talents.

The average utilities for the feature "type of employer" reveal a preference for multinational corporations, which may be explained with the lower risk multinational companies face of being closed or failing. However, the relative importance of the feature is smaller than others.

Instead, the type of work can have a stronger influence on jobseekers' preference for a position and the results show that respondents dislike physically active work and would rather opt for mixed tasks, alternating office work with physical work.

Remuneration also plays an important role in determining preferences. Perhaps not surprisingly, respondents opt for greater security (basic salary and bonus) and express strong dislike for commission-based remuneration.

Although the qualitative data collected for this study suggest that health and safety are a major concern for those working or considering working in the steel sector, the conjoint analysis indicates that offering an additional health insurance as a benefit would not make a certain position much more attractive. Company amenities, instead, seem to be sought for and skills training and continuous learning can also be an attractive element.

Finally, a central place of work is preferred, which is in line with the qualitative data. Respondents stress the importance of a good location, which is easy to reach and does not require long commuting time. Steelworks tend to be considered less attractive than other workplaces as they are often located in places that tend to be less dynamic than city hubs and lack other infrastructure like schools or hospitals. Yet, this feature does not have a substantial relative importance, which means that more important features should be considered first when devising ways to make steel-related careers more appealing.

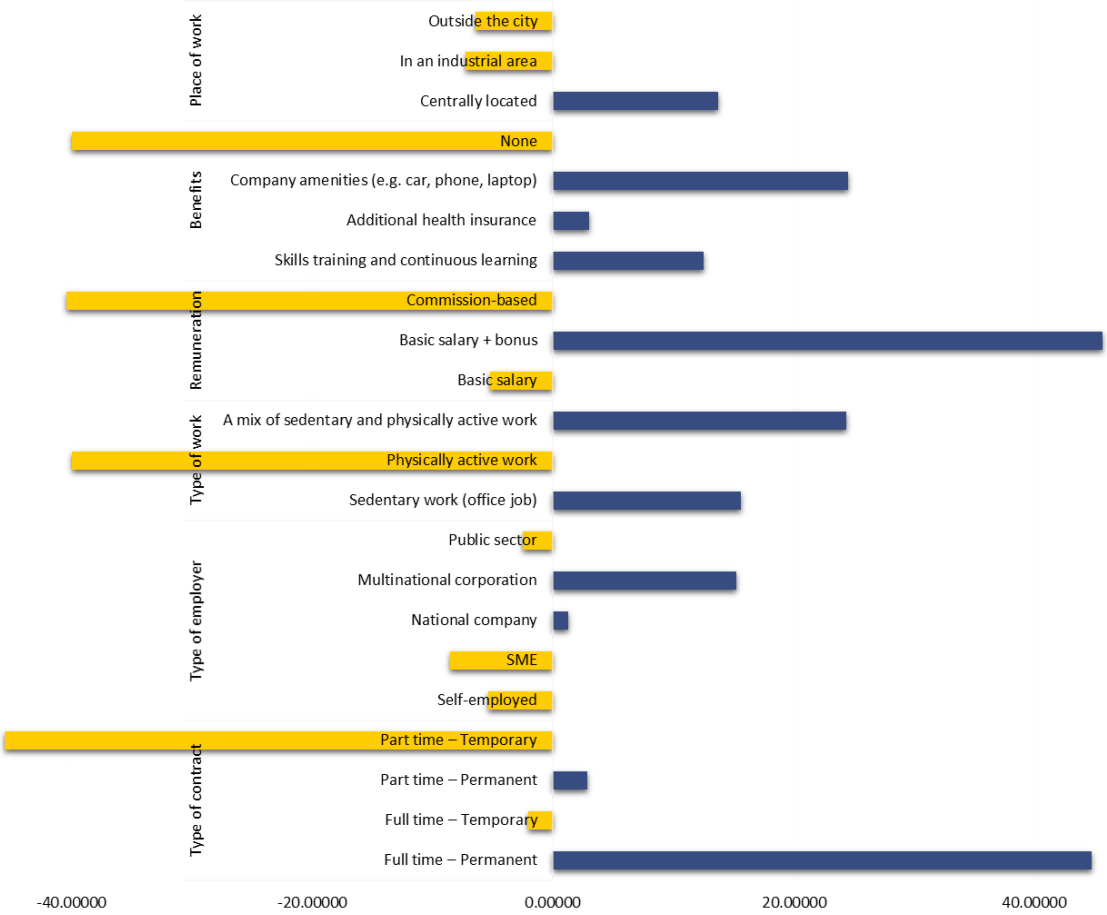

Figure 5 — Visual illustration of average utilities per attribute

An in-depth review of the results from the online survey for students, graduates and jobseekers made it possible to identify some of the factors that can affect (positively or negatively) the respondents' willingness to work in the steel sector. The key variable for this measurement, "Willingness to work in the steel sector" was created by integrating two survey items[111] (both scaled, Likert 1-5), notably:

- How interested are you in working in the steel industry?
- How willing would you be to do an apprenticeship in a steelwork?

A linear regression model was used to test potential determinants of respondents' willingness to work in the steel sector. Given the large sample, the study team tested the items without using scales to have more detailed information about potential factors.

The results of the model (R Square .420[112], VIF<2.5) are presented in Table 4. The highlighted variables are the ones found statistically significant. These are the factors that make a difference – either positive or negative – in shaping the willingness to work in the steel sector. Items that are not highlighted are not statistically significant. These are factors that were not found to affect one's willingness to work in the steel sector. Therefore, using them as levers to attract jobseekers is less likely to be effective or efficient.

For each item, beta values, t values and p values (Sig.) are displayed. P values indicate the significance of each factor and have a cut-off value of 0.05. T values are closely related to p values since they indicate the extent of evidence for a significant difference: the greater the t value, the greater the evidence that there is a significant difference; conversely, the closer the value is to .000, the higher the likelihood that there is no

[111] The Cronbach Alpha was found to be .845.
[112] 42% of the variance in the willingness to work in the steel sector is explained by the items in the model.

significant difference. Beta values indicate the direction of the influence that each of them has on the willingness to work in the steel sector: if beta values are positive, it means that the higher the value of the factor, the higher the willingness to work in the steel sector.

Table 4 — Determinants of the willingness to work in the steel sector

Model	Unstandardised Coefficients		Std Coef.	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	2.155	.164		13.173	.000
Q1: Good advancement opportunities	-.007	.016	-.010	-.455	.649
Q1: International career	.052	.011	.092	4.546	.000
Q1: Task variety	.010	.018	.013	.571	.568
Q1: Contribution to societal goals	-.005	.014	-.007	-.351	.726
Q1: Participation in decision-making	-.021	.015	-.030	-1.390	.165
Q2: I find working in shifts attractive	.059	.010	.105	5.645	.000
Q2: I need to have a clean and quiet working environment	-.018	.013	-.027	-1.406	.160
Q2: I want to have good relations with the management	-.030	.019	-.039	-1.539	.124
Q2: I want to have good relations with colleagues	-.008	.019	-.011	-.430	.667
Q2: In a new job, I look for independency	-.018	.014	-.024	-1.245	.213
Q7: Work in the steel industry is still very manual/physical	.024	.014	.033	1.715	.086
Q7: Steelmaking requires significant digital skills	.027	.014	.038	1.965	.050
Q7: Most jobs in the steel sector are low skilled	-.018	.013	-.027	-1.395	.163
Q7: Having a higher education degree is important to work in the steel sector	.023	.014	.034	1.685	.092
Q7: An apprenticeship is important for working in the steel industry	.025	.014	.035	1.802	.072
Q7: No qualifications are needed to work in the steel industry	.013	.012	.020	1.048	.295
Q8: Steel companies make efforts to improve sustainability	.050	.015	.069	3.279	.001
Q8: Working conditions in steel plants are generally good (e.g. clean and quiet working environment)	.002	.014	.003	.160	.873
Q8: Work-life balance in the steel industry is acceptable	.013	.017	.016	.754	.451
Q8: Steel companies care about their workers' safety and working conditions	-.033	.016	-.043	-2.043	.041
Q8: There is a high risk of work accidents in the steel sector	.005	.015	.006	.312	.755
Q9: Salaries in the steel industry are attractive	.055	.016	.071	3.351	.001
Q9: The steel industry offers stable positions	.012	.017	.015	.714	.475
Q9: The steel industry offers exciting career opportunities	.056	.018	.075	3.080	.002
Q9: Working in the steelmaking industry is a respected (prestigious) occupation	.058	.016	.084	3.720	.000
Q9: The steel industry offers enough opportunities to be promoted	.000	.018	.001	.025	.980
Q10: Have you ever considered a career in the steel industry?	-.647	.041	-.315	-15.784	.000
Q10: Have career opportunities in the steel sector been discussed with you during your studies?	-.224	.043	-.101	-5.164	.000
Q10: Have you ever visited a steelmaking plant?	-.197	.041	-.091	-4.834	.000
Q10: Have you followed any training/apprenticeship related to the steelmaking industry?	-.201	.057	-.074	-3.549	.000
Q10: Have you ever worked in the steel sector?	-.146	.061	-.050	-2.381	.017
Q12: Age	.006	.002	.053	2.957	.003

a. Dependent Variable: Willingness to work in the steel sector

Only few career aspirations and beliefs were found to be significant (having a job that offers an international career, finding working in shifts attractive), while some perceptions and attitudes about working in steel were also found to have a significant effect (steel careers require digital skills, steel companies make efforts to increase their sustainability). The greater these beliefs and perceptions, the higher the willingness to work in the sector. Variables in relation to the attractiveness of steel careers (salaries, career opportunities, respect/prestige) were found significant, as it is also the case for respondents' age (older respondents are more likely to be willing to work in the steel sector). It is noteworthy, however, that some of the most significant factors are those related to previous experience with the steel sector. Respondents who had experience with the sector (from simply considering careers in the steel industry to having worked in the steel sector) are significantly less likely to be willing to work in the sector.

Several ANOVA tests were run to test the effect of some demographic-type variables on the willingness to work in the steel sector. The effect of current employment status was statistically significant: undergraduate respondents show less willingness to work in the sector in comparison to other professional status options.

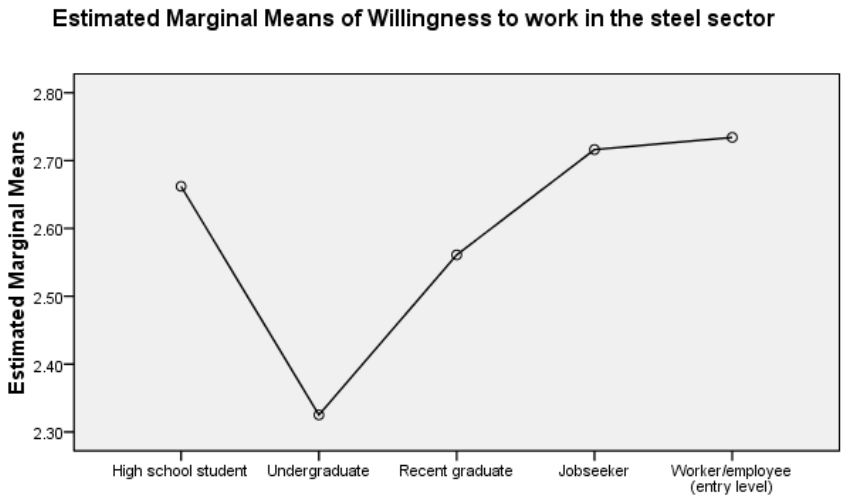

Figure 6 — Relation between professional status and willingness to work in the steel sector

Education levels are marginally insignificant (p .069) but the tendency is that more educated respondents are more willing to work in the sector.

Besides testing the relation between independent variables or demographics and the willingness to work in the steel sector, a cluster analysis was used to identify statistically significant factors that characterise clusters of respondents. A subset of the factors that were found to be significant was used to algorithmically test for meaningful groupings of respondents (based on numerical distance). Five survey items regarding Steel sector attractiveness (see Q9) were integrated in one new variable to further facilitate the exercise (Cronbach Alpha .807). For the test, all variables were standardised to improve the k-means results and facilitate the interpretation of the clustering results. Five clusters emerged, as shown below. Table 5 presents the size and mean Z-score (0 is the mean, Std Dev=1) for each cluster per variable.

Table 5 — Cluster analysis

Final Cluster Centers

	Cluster				
	1	2	3	4	5
Size	*560*	*349*	*390*	*379*	*324*
Zscore: Willingness to work in the steel sector	.098	-.721	-.682	.325	1.046
Zscore: Q1: international career	-.034	.451	-1.247	.281	.745
Zscore: Q2: I find working in shifts attractive	.746	-.337	-.701	-.889	.956
Zscore: Q8: Steel companies make efforts to improve sustainability	.102	-1.069	-.216	.335	.844
Zscore Sector Attractiveness (Q9 Scaled variable)	-.078	-1.113	-.253	.429	1.138

Cluster 5 is the most positive group towards working in the steel sector (on average it scores one standard deviation higher). This cluster scores high (as expected) in all key variables and finds the steel sector very attractive. This seemingly "star" cluster is the smallest in size (324 participants). It appears to be composed by slightly more educated people (the percentage of respondents with a university degree or a PhD title is higher than in the other cases).

Cluster 4 has a moderate size. Respondents pertaining to this cluster are willing to work in the steel sector and find the sector considerably attractive. In the context of this study, these are the "hopefuls". However, working in shifts is a serious constraint for this cluster and could be a potential issue of importance.

Cluster 1 is the largest segment and is moderately willing to work in the steel sector. Respondents in this cluster are positive about shift work and rather indifferent about international careers, but score lower in how attractive they find the sector.

Clusters 2 and 3 score are not willing to work in the steel sector. They differ in their scores along the other variables (e.g. cluster 2 is interested in an international career, while cluster 3 is not at all interested in having an international career) but they both find the sector unattractive (group 2 is very negative). Cluster 2 includes a slightly higher number of undergraduates than all the other groups, while cluster 3 has the highest percentage of employees/workers at an entry level and lower levels of education (high percentages of respondents hold a secondary education diploma or a Bachelor). In both cases, it would take considerable persuasion to change the willingness of these people to work in the steel sector.

The study tested these segments (based on self-reports) with the behavioural intent that was measured after the (supposed) end of the study, allowing for a more robust measure of real intentions. The results are rather surprising: the crosstabulation table below shows that there are significant differences (p .000) among the five groups with regard to their answer in the behavioural intent question (i.e. Would you like to receive more information concerning careers in the steel sector?). Cluster 5 (the "stars") scores the lowest (only 47.2% would like to receive more information) while the two negative clusters (2 and 3) are much more open to receiving more information concerning careers in the steel sector. While there could be many explanations for this result (e.g. positive groups might already have information, a psychological process at play), this is a piece of counterintuitive information that is worth considering.

Table 6 — Crosstabulation between clusters and behavioural intent

Crosstab

			Would you be interested in receiving more information concerning careers in the steel sector?		
			No	Yes	Total
Cluster Number of Case	1	Count	159	401	560
		% within Cluster Number of Case	28.4%	71.6%	100.0%
	2	Count	74	275	349
		% within Cluster Number of Case	21.2%	78.8%	100.0%
	3	Count	72	318	390
		% within Cluster Number of Case	18.5%	81.5%	100.0%
	4	Count	119	260	379
		% within Cluster Number of Case	31.4%	68.6%	100.0%
	5	Count	171	153	324
		% within Cluster Number of Case	52.8%	47.2%	100.0%
Total		Count	595	1407	2002
		% within Cluster Number of Case	29.7%	70.3%	100.0%

4.2.3. Actions and initiatives to improve the image of steelmaking

To meet the European Commission's goal to preserve and increase employment opportunities in steelmaking, the image of the industry must change drastically, namely by overcoming the prevalent opinions labelling it as an unstable, unwelcoming, and unhealthy working environment. Over the years, the industry has taken steps to counter these misconceptions.

In this respect, World Steel has been particularly active at global level. For instance, it launched the *#lovesteel* campaign to showcase steel as an indispensable part of modern societies. The first phase of the campaign, which ran between 2013 and 2015, comprised a series of video interviews with young professionals from World Steel's member companies who shared their workplace experience. The purpose of the videos was to give people a better sense of what working in steelmaking is all about. The second phase of the campaign, launched in 2015, aims at showcasing the role played by steel in different

aspects of modern living. It breaks down into different pillars, showing how steel is a crucial part in sea and rail transport, home appliances, medicine, sports facilities, etc.[113].

Through its learning and training programme named "steeluniversity", World Steel organises the SteelChallenge world championship, where students and industry professionals are asked to take part in a series of simulation-based exercises to find concrete solutions to real problems that steel companies face. SteelChallenge-13, which took place in November 2018, tasked competitors to use an Integrated Basic Oxygen Steelmaking and a Secondary Steelmaking Simulator to produce a grade of steel meeting technical requirements at the lowest cost per tonne. 1,905 participants attended from over 50 countries, and the top-ranked students and industry professionals in each region participated in the World Championship held on 16 April 2019 in Madrid[114]. SteelChallenge-14 took place in November 2019 with 2,003 contestants from 57 countries, who had 24 hours to produce a grade of steel meeting technical requirements at the lowest cost per tonne using an EAF simulator and a secondary steelmaking simulator. According to the organisers, the SteelChallenge is particularly popular in China, India and South Korea, whereas participation remains low in European countries. SteelChallenge-13 was attended by about 50-60 European students, mostly from Germany, the Netherlands, Slovenia, and the UK, thanks to the support of Thyssenkrupp and Tata Steel Europe[115]. 34% of the participants in SteelChallenge-14 came from the North of Asia, 27% from East Asia and Oceania, about 16% from the Americas, 15% from Western Asia and only 8% from Europe and Africa.

In Europe, the most relevant actions to re-brand the steel industry are being undertaken at local levels. Almost all the major European steelmakers dedicate substantial efforts to strengthen their ties with the local communities living near their production sites. Community engagement is at the core of the social responsibility strategy of many European steelmakers, and several initiatives are implemented in the form of financial contributions, participation in charity initiatives, support to employees and their families, and partnerships with local schools. These initiatives have been classified under four overarching groups:

- Bringing students closer to steelmaking;
- Promoting engineering and technical jobs among non-traditional groups;
- Unlocking the potential of migrants (especially refugees) to fill skills shortages in the industry;
- Tackling the climate debate at community level.

Bringing students closer to steelmaking

Engaging with students in primary schools and high schools has been identified as a key priority by many experts interviewed in this study. Making science education and careers attractive for young people, who represent the workforce of tomorrow, appears as a strategic goal in the agenda of governments all around Europe, and is also a top priority for STEM-related industries such as steelmaking. Many European companies have undertaken initiatives to engage with primary school and secondary school students, with a view to bring them closer to manufacturing and show them the attractiveness of engineering and technical careers.

The table below shows an overview of the main actions analysed in this study, either through primary or secondary data collection.

[113] See:https://www.worldsteel.org/media-centre/lovesteel.html, Last visited on 24.05.2019
[114] See: https://steeluniversity.org/steelchallenge-13/, Last visited on 24.05.2019
[115] Interview notes - Education Providers, Senior representative from steeluniversity

Table 7 — Initiatives targeting students and young people

Name	Description	Organisation involved	Country
PET IJmond	The PET IJmond initiative, which reached its 12th edition in October 2018, is co-organised by Tata Steel Europe in the framework of Techport, the Dutch Smart Industry field lab[116] for the manufacturing and maintenance industry. PET IJmond gathers over 1,700 students from 55 primary schools in the IJmond area for a series of workshops organised by companies and demonstrating the value of engineering and technical professions[117].	Tata Steel Europe	NL
Becas Robótica Educativa and Aula STEM	The Becas Robótica Educativa (Robotics Scholarships) and Aula STEM (STEM Class) is an initiative organised by ArcelorMittal Sagunto to promote technical disciplines among high school students. The 2017-2018 edition awarded scholarships to local high school students, allowing them to participate in extra-curricular training activities such as robotics, 3D modelling and programming[118].	ArcelorMittal Sagunto	ES
"Machina et Schola"	To combine STEM disciplines and humanities, this project aims to engage high school students and teachers in an interactive reconstruction of the history of Sagunto by using steel and metals as a common thread[119].	ArcelorMittal Sagunto	ES
ZainSTALuj się	ZainSTALuj się is a scholarship and training programme for students who would like to enter the steel industry. In the framework of the programme, students from technical high schools and vocational schools can apply for free apprenticeships in one of the company's local branches[120].	ArcelorMittal Poland	PL
Apprenticeships for school students	The steel producer CMC Poland Sp. Z cooperates with several high schools in the Zawiercie area, offering scholarships to pupils and students[121].	CMC Poland Sp. Z	PL
Olympiades des Sciences de l'Ingénieur	The "Olympiades des Sciences de l'Ingénieur" is a competition for last-year high school students interested in engineering science. ArcelorMittal's	ArcelorMittal Montataire	FR

[116] Smart Industry field labs are public private partnerships established to develop, test and implement Smart Industry solutions and transformations in the Netherlands. Techport was established as the result of the Techniekpact (Technology Pact) and brings together 11 industrial and academic partners.
[117] Economische Samenwerking IJmond, Jaarplan 2018, 2018
[118] ArcelorMittal España, Informe de Sosteibilidad 2017, 2017, p.98
[119] See: https://spain.arcelormittal.com/news-and-media/press-releases/2018/junio/machinaetschola.aspx, Last visited on 20.05.2019
[120] See: http://www.zainstalujsie.pl/#c52, Last visited on 24.05.2019
[121] See: https://www.cmc.com/de/global/cmccareers/spark-your-career/benefitseurope?crawlerid=6f34e000-8817-433b-8d45-1a51cbcb02fd&cidhash=75cc5d6398abc74fd81d1fbf5fe81dc78b450d3c835d599ce3977f1a4baccf2c, Last visited on 14.06.2019

Name	Description	Organisation involved	Country
	Montataire research centre has been a partner of this initiative for several years[122].		
Apprenticeships for school students	In 2017/2018, thyssenkrupp offered 3,162 apprenticeships in 62 different occupations to high school graduates, mostly in Germany. In the same year, 340 apprentices enrolled in integrated degree programmes, which combine academic study and in-firm vocational training. The quality standards of these integrated degree courses is guaranteed by a collective agreement signed with the German metallurgy union IG Metall[123].	thyssenkrupp	DE
3-19 ~ Fondazione Dalmine per le scuole	Fondazione Dalmine was created in 1999 to promote industrial culture in the Dalmine and Bergamo areas (Lombardy). In the framework of the "3-19" project, the foundation organises workshops, visits and cultural activities for pre-school, primary school, and high school students and teachers, focusing on the promotion of the Italian industrial culture and heritage[124]. The foundation also welcomes university students, offering them personalised tutoring to develop their master and PhD thesis[125].	Dalmine SpA	IT
Italian steelmakers and Alternanza Scuola-Lavoro	Italian steel companies can take advantage of the opportunities offered by the reform of the educational system introduced by the law 107/2015, commonly known as "Alternanza Scuola-Lavoro" (school-work alternation), which introduced compulsory training for high school students. Many have already done so, strengthening the ties with high schools near their production sites. In the framework of its "Bootcamp" project, the Feralpi Group offers an eight-week training programme to technical school students in the Brescia area. The programme is provided by the company technicians and external partners, and focuses on providing students with a transversal skillset including basic steelmaking competencies, communication and teamwork skills, as well as a knowledge of Occupational Safety and Health (OSH) practices. In 2016, Lucchini RS organised the Delta Junior project in its Lovere headquarters, in collaboration with two local high schools. The aim of the project was to engage students in putting forward solutions to meet	Feralpi, Lucchini, Marcegaglia, Arvedi	IT

[122] ArcelorMittal France, Rapport de responsabilité sociétale 2017, 2017, p.45
[123] thyssenkrupp, *Annual Report 2017/2018*, 2018, p.92
[124] See: http://3-19.org/, Last visited on 24.05.2019
[125] Federacciai, *Rapporto di sostenibilità 2017*, 2017, p.114

Name	Description	Organisation involved	Country
	real-life production challenges faced by the company. Additionally, several steelmakers such as Marcegaglia and the Arvedi Group organise regular visits to their steel mills for high school groups.		

Promoting engineering and technical jobs among girls and women

According to the World Economic Forum's (WEF) latest data, job families that are directly related to steelmaking are still characterised by a relatively high gender gap. Looking at the statistics, the share of female employment is 23% in manufacturing, 25% in energy and mining, and 27% in software and IT services. Despite an overall growth in hiring of female talent over the last 10 years (+6.4% in software and IT services, +4.5% in manufacturing, +1.8% in energy and mining), women are still underrepresented in all of these sectors[126], and make up a comparatively small share of skilled production workers and science and technology engineers across Europe.

Women represent by far the largest untapped group of talent to work in manufacturing, especially now that increasing levels of automation are making the industry less labour-intensive. As the Manufacturing Institute, initiator of the STEP Forward and STEP Ahead initiatives[127], puts it:

> "*[w]omen represent one of the largest pools of untapped talent for manufacturers. Thus, closing manufacturing's gender gap is key to closing the skills gap too. Moreover, research shows that gender diversity benefits a manufacturing firm by improving its ability to innovate and grow*"[128].

In light of this, it comes as no surprise that many initiatives addressed at schools and universities specifically target girls and young women. The table below provides an overview of the initiatives identified in this study.

Table 8 — Initiatives targeting girls and young women

Name	Description	Organisation involved	Country
Girls' Days	Since 2007, Tata Steel Europe hosts the Girls' Days, a nationwide event aimed at promoting the image of science and engineering amongst schoolgirls[129]. In 2019, about 140 girls from lower secondary schools visited Tata Steel Europe in Ijmuiden for two days of practical workshops with female managers and employees of the company[130].	Tata Steel Europe	NL
Femmes de steel	In France, female employees of ArcelorMittal Fos-sur-Mer have created the network "Femmes de steel", aimed at promoting steelmaking among young girls and women. Each year, the network organises an open doors day, during which primary school and	ArcelorMittal Fos-sur-Mer	FR

[126] World Economic Forum, The Global Gender Gap Report 2017, 2017, p.34
[127] STEP Forward is aimed at educating representatives from the manufacturing industries on attracting and retaining female employees, while STEP Ahead gives awards to the best female leaders in manufacturing
[128] 'STEP Ahead – Women in Manufacturing', http://www.themanufacturinginstitute.org/Initiatives/Women-in-Manufacturing/STEP-Awards.aspx, Last visited on 07.06.2019
[129] Tata Steel Europe, Sustainability Report - Tata Steel in the Netherlands 2015-2016, 2016, p.42
[130] See: https://www.Tatasteeljobs.nl/nieuwsberichten/2019/girls-day-2019.html, Last visited on 20.05.2019

Name	Description	Organisation involved	Country
	high school girls can interact with women in operational positions (e.g. maintenance technicians, production operators, engineers, etc.).		
Sciences de l'Ingénieur au Féminin	In Dunkirk, ArcelorMittal participated in the 4th and 5th edition of "Sciences de l'Ingénieur au Féminin", an initiative aimed at raising awareness on scientific careers among high school girls[131].	ArcelorMittal Dunkerque	FR
Mujeres de Acero	"Mujeres de Acero" ("women of steel") is a series of articles launched in 2016 by the Association of Spanish Steel Producers UNESID. Every year on the International Women's Day, "mujeres de Acero" celebrates female talents in Spanish steel plants, showcasing their work in R&D, production areas, and administration.	UNESID	ES

Unlocking the potential of migrants, particularly refugees to fill skills shortages in the industry

As a joint study by the European Commission and OECD points out, refugees represent one of the most vulnerable groups of migrants on the European labour market. "… one in five economically active refugees is unemployed and one in eight is unemployed for 12 months or longer and about one in fourteen was unemployed for 2 years or longer, suggesting that once unemployed, refugees have difficulties to return to employment"[132]. A high proportion of refugees are aged between 18 and 34, which is the typical HE population range, and many of them were already enrolled in HE programmes in their own countries[133]. The integration of refugees in the European labour market through comprehensive up-/reskilling policies has been acknowledged as a priority by the European Commission. This, however, should go hand in hand with forward-looking company-led strategies and corporate management, which could leverage the potential of refugees, and migrants more generally, to face shortages of skilled labour in strategic sectors of European economies[134].

In this sense, Germany seems to have put in place a comprehensive policy approach for the integration of refugees, with a strong spill-over effect on the German industry. A clear example of this is provided by "We Together" ("Wir Zusammen – Die Integrations-Initiative der deutschen Wirtschaft"[135]): Launched in 2016, "We Together" is a network of 36 German companies committed to integrating refugees within their workforce. As one of the founding partners of this network, thyssenkrupp pledged to create 150 apprenticeship places and

[131] ArcelorMittal France, Rapport de responsabilité sociétale 2017, 2017, pp.20-21
[132] European Commission, OECD, How are refugees faring on the labour market in Europe? - A first evaluation based on the 2014 EU Labour Force Survey ad hoc module, Working Paper 1/2016, European Union, 2016, p.5
[133] European Commission/EACEA/Eurydice, Integrating Asylum Seekers and Refugees into Higher Education in Europe: National Policies and Measures. Eurydice Report, Luxembourg, Publications Office of the European Union, 2019, p.5
[134] See on the use of migrant labour, its historical dimension and the linkages between national and supra-national policy and corporate management strategies Stroud, D. and Fairbrother, P., "Training and workforce transformation in the European steel industry: questions for public policy", in Policy Studies, 29(2): 145-161, 2008
[135] thyssenkrupp, Annual Report 2017, 2017, p.93. See also: https://www.wir-zusammen.de/, Last visited on 20.05.2019

230 internships for refugees, on top of the already existing 150 apprenticeships and 400 internships[136].

Taking the climate debate at community level

One of the key issues affecting the image of the steel industry is the public perception of steelmaking as an unsustainable and highly polluting industry. This perception does not reflect the investments made by the industry to increase its sustainability. Many European steelmakers have engaged in developing cutting-edge technologies and processes to meet the EU's climate targets for 2050 and are making efforts to showcase their contribution to the UN's Sustainable Development Goals (SDGs). According to many expert interviewees, improving the image of steelmaking as a sustainable industry also requires social responsibility efforts to raise awareness about steel being a fully recyclable material and steelmakers' engagement to support circular economy practices.

The table below describes a series of local initiatives that emerged as possible best practices from data collection.

Table 9 — Community initiatives to promote sustainability

Name	Description	Organisation involved	Country
Open-door events for neighbours	The Finnish steelmaker Outokumpu, which is the largest stainless-steel producer in Europe (with production sites in Finland, Germany, Sweden, and the UK), regularly organise open-day events to engage local communities on existing and potential solutions to reduce its environmental footprint[137].	Outokumpu Oyi	FI, DE
MAŁA ARTzona	ArcelorMittal Poland invested around PLN 1.8 million in community initiatives in 2017. One of the key projects is MAŁA ARTzona, a series of workshops carried out yearly with the Norwid Cultural Council in Krakow to teach children about upcycling and how to create new objects out of used raw materials[138].	ArcelorMittal Poland	PL
RicircoliAMO!	In the framework of the Feralpi Bootcamp, the Feralpi group involves the children of its staff in different activities aimed at promoting workplace safety, career development, and sustainability awareness. The latter was at the core of the event RicircoliAMO!, during which children were involved in a full day of activities showing them the scrap steel and waste recycling processes applied in the company's production sites[139].	Feralpi	IT
Council of Children	In the Netherlands, pupils aged between 10 and 12 from the IJmond area can participate in Tata's Council of Children. "Once a year, the Council has a dialogue with the board of Directors on themes such as the environment and innovation. These meetings are chaired by	Tata Steel Europe	NL

[136] thyssenkrupp, Annual Report 2017, 2017, p.93
[137] See: https://www.outokumpu.com/fi-fi/sustainability/people-and-society/outokumpu-and-society, Last visited on 24.05.2019
[138] ArcelorMittal Poland, Sustainability Report, 2017, p.48
[139] See: http://www.feralpigroup.com/orientamento/, Last visited on 24.05.2019

	Princess Laurentien van Oranje, a director of Unicef's Missing Chapter Foundation (MCF)" [140].		

The actions outlined in this chapter show that some steel companies are indeed taking up the challenge of overcoming steel's traditionally negative image by leveraging their strong local presence as employers. Apart from connecting with local communities, steel companies have been substantially increasing their investments in marketing and communications. The case of British Steel is emblematic, when in 2016, the company underwent a complete rebranding, starting an intense communication campaign on social media to promote steelmaking as a challenging and attractive work environment. A similar use of social media has been made by other major steel companies as well as producers' associations[141].

A large group of stakeholders involved in this study state that more efforts are needed, especially as the steelmaking industry still appears to lack a clear and unified message tackling the key areas where misconceptions around it lie, i.e. sustainability, working conditions and technology. All in all, steel companies and associations still fail to embrace a common message promoting the industry as a whole rather than conveying a single company's view.

4.3. Skills needs

The European steel industry has experienced a paradigm shift over the last decade. The slowdown of the global steel market, recurring overcapacity and the emergence of major industrial economies with increasingly high production levels such as China and India, has considerably weakened Europe's position on the international stage. In addition, European steelmakers are also faced with financial uncertainty linked to exogenous and endogenous factors such as the steel and aluminium tariffs imposed by the US and Brexit, which was pointed as the main underlying cause leading to the recent collapse of British Steel. The outbreak of the COVID-19 pandemic in 2019-2020 has further challenged the steel industry with a substantial slowdown, which may require new approaches to production and distribution of steel and is likely to affect the current and future workforce.

In light of these trends and changes, the European industry needs to compete on the global steel market by investing in R&D&I and producing high-quality products, such as lightweight high-strength alloys for cost-effective and sustainable vehicles. According to several experts involved in this study, such a strategy will impact how the industry will select new talents and train its resources.

4.3.1. A look at the current situation: skills needs

The speed at which the industry is assimilating new technologies is increasing. Applied solutions rely more and more on synergies between different competencies. There is a need for stronger horizontal skillsets rather than very specialised profiles – companies' needs seem to move towards T-shaped skillsets[142]. The latter include an area of specialty complemented with a series of transferable skills, which can be grouped in three overarching categories: general technical skills, digital skills and soft skills. The issue of transferability has been cited as key by many expert interviewees. Industry representatives expressed the need to have workers with transferable skillsets to ensure a good level of flexibility and coordination within different departments of their companies. As managerial

[140] Tata Steel Europe, Sustainability Report - Tata Steel in the Netherlands, p. 42

[141] For reference, we cite the videos "British Steel | The movie - an exciting look into how we make steel" (https://www.youtube.com/watch?v=pJfiEylPpmY), realised by British Steel, "I am Steel" (https://www.youtube.com/watch?v=9GL221M-tPA), realised by ArcelorMittal, "De toekomst van staal en de rol van Tata Steel" (https://www.youtube.com/watch?v=Qqdf9d7z9rQ, realised by Tata Steel Europe, and "A film about steel and the steel industry in Sweden", realised by the steel producers' association Jernkontoret

[142] The notion of "T-shaped" skills has emerged over the last 10 years. It generally refers to people possessing a combination of specialist skills in one specific domain and general skills in other relevant domains

models adopt leaner structures, it becomes increasingly important for companies to have employees who are able to move comfortably across multiple tasks and intervene in different areas of the value chain. Several trade union representatives pointed out that, in a sector affected by long-lasting job insecurity problems, transferable cross-functional skills can represent a source of security for workers.

The horizontal skills mentioned above can vary substantially according to the different job profiles for a steel plant. In general, regarding soft skills, managerial profiles increasingly require combining people skills such as communication, team spirit and leadership with a business-oriented mindset. Especially for engineers and production managers, entrepreneurial skills seem to be in high demand among employers (as shown by the requirements described in the reviewed job ads). This could be explained by the need to complement technical knowledge with a solid understanding of the steel market and customer needs. As stated by a representative from a major European steel producer:

> *"market skills are essential: you cannot only produce, you also need to understand what the needs for downstream industries and people in general are so that you can improve your products (e.g. different types of steel) and increase the opportunities to use steel in the market"*[143].

Concerning technicians and metalworkers, Cedefop identifies problem solving, teamwork and communication as the underpinning core skills to undertake a job in the sector[144]. Job ads analysis identified a broader range of skills, including cross-functional thinking, curiosity, and adaptability. Steelworkers are no longer required to simply perform a task, but rather to understand how that task fits in the overall functioning of the steel plant. This requires them to be willing to continuously improve and update their skills. As stated by one interviewee from a national sectoral organisation, "employees need the ability to systematically improve their professional qualifications; this is necessary in the era of rapid technological progress"[145]. In summary, while managers appear to be required to integrate more market-oriented skills, skills like critical thinking, complex problem solving, and independent and informed decision-making seem to apply transversally across all levels of specialisation.

Competencies in engineering, material science, mathematics, physics, and chemistry are seen as crucial to work in the steel industry[146]. Additional technical skills include project management, planning and scheduling, which appear to be increasingly required in the context of continuous process optimisation. Finally, digital skills also appear to be in growing demand, not only for emerging technical profiles related to information technologies such as ICT specialists and data analysts, but also for technicians at all levels (further details are provided below). In effect, various profiles require a combination of skillsets (such as technical and digital), as these have become integrant to one another.

To further assess which competencies are perceived as the most needed by the industry, this study resorted to MaxDiff (an advanced statistical analysis method) in the multi-component survey for industry professionals (Survey 1). The survey targeted workers in the steel industry, focusing on people in charge of selecting new hires and training the personnel. The survey was built using a sectoral approach rather an occupation-specific approach. This choice was motivated by the need to identify a set of skills or rather skill clusters that can be generalised to the steelmaking sector as a whole, so as to maintain a broad sectoral scope and identify wider trends and areas for coordinated action at European level. Based on secondary data collection, the study team developed a shortlist of steel-

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[143] Interview Notes - Industry Stakeholders, Director of a steelmaking company
[144] Cedefop, "Metal & machinery workers: skills opportunities and challenges (2016)", https://skillspanorama.cedefop.europa.eu/en/analytical_highlights/metal-machinery-workers-skills-opportunities-and-challenges, Last visited on 05.06.2019
[145] Interview notes - Industry Stakeholders, Senior representative at ESTEP
[146] World Steel, Fact Sheet - Working in the steel industry, February 2019, https://www.worldsteel.org/en/dam/jcr:597ab555-3b9e-4177-bcd3-604e4d6e5a2b/fact_Employment_2019.pdf, Last visited on 05.06.2019

related skills, and respondents were asked to select those that they considered as the most important for workers and new hires. These include:

- Specialised technical skills: Scientific and operational skills that are needed to perform very specific tasks that require specialised knowledge in terms of operations, processes or materials (e.g. welding, machining);
- Advanced technology skills: Knowledge of Key Enabling Technologies such as micro and nanoelectronics, nanotechnology, industrial biotechnology, advanced materials, photonics, or advanced manufacturing technologies;
- Manual dexterity: Capacity to perform manual operations skilfully and rapidly;
- Digital skills: Confident and competent use of digital technology;
- Managerial skills: Critical thinking, problem solving and decision making;
- Data skills: Monitoring data, understanding data and assessing it (with regard to, for instance, Big Data, industry 4.0, predictive maintenance, robotisation, etc.);
- Soft skills: Communication, interpersonal skills, capacity to interact and collaborate
- Languages: Capacity to understand and communicate in foreign languages;
- Green skills: Competences in circular economy, environmental issues, resource reutilisation/recycling, sustainability.

According to the analysis, specialised technical skills and advanced technology skills are considered the most important skills in a candidate (the skills have respectively a relative importance of 22% and 21%, as shown in Figure 7). This is further confirmed by interviews and job ads analysis. According to several interviewees covering managerial positions in steel companies, the industry needs people with a solid technical skillset, including a strong knowledge of material science, a good understanding of extraction processes, as well as product development processes. While sector-specific competencies are generally provided to workers through on-the-job learning and in-firm training, a solid knowledge of production processes is still widely regarded as the most important characteristic to work in the industry.

With regard to specialised manual profiles (such as steel shop operators, maintenance operators, rolling and casting operators, etc.), findings highlight the need for workers with a solid knowledge of metallurgical and industrial processes that are relevant to steelmaking. These can include alloying techniques, refinement processes, temperature and composition adjustment, deoxidation and desulfurisation processes, hydrogen and nitrogen removal, decarburisation, etc. More generally, knowledge of mathematics, chemistry, material science and metallurgy were considered paramount, along with an understanding of welding, foundry, process control and management. Looking at more specialised managerial positions (e.g. production engineers, system engineers, production managers, etc.), the focus shifts towards more technology-oriented skillsets, with a strong focus on the skills related to I2M[147]. Being familiar with process control and maintenance methodologies appears to be a fundamental requirement for future hires, with the highest demand in the optimisation of manufacturing processes.

Manual dexterity and digital skills have a relative importance of 11%, showing that there is still a strong demand for workers who are able to perform manual operations on machinery and display a good level of proficiency in the use of computers. Among the general IT tools that workers are required to use, the most common are the Microsoft Office suite and SAP, as well as company-specific software for production planning and scheduling, logistics and project management. As many steel company representatives pointed out, the use of computers is no longer linked to specific departments or tasks, but has become a general requirement. This is mainly due to digitalisation and the Internet of Things (IoT), as several physical processes become increasingly connected to digital software and tools. As a result, steel shop operators work more and more remotely with respect to production lines, and the vast majority of interactions are managed via

[147] Following the definition provided by the relevant working group in ESTEP, I2M is defined as a system for manufacturing supply which is characterised by integrated monitoring, control and management processes. The goal of I2M is to optimise production processes and resource efficiency through an increased connectivity among the networks of sensors used in the different steps of production.

computer. Real-time sensing is a reality in a variety of processes, ranging from primary to secondary steelmaking (i.e. from the manufacture of steel to post steel-making processes occurring in the ladle[148]). At higher levels of specialisation, the most sought digital skills pertain to advanced practices such as 3D design and modelling[149] – technical workers are often expected to be able to interact proficiently with a variety of software and computer programmes.

Managerial skills and data skills rank almost at the same level, with respectively 10% and 9% of relative importance. By contrast, these skills emerged as being the most prominent from the interviews carried out with sectoral experts. This is arguably due to the fact that these skills are most relevant for specialised analytical and managerial profiles, which are expected to play an increasingly important role to respond to the future challenges of the industry. Concerning data skills, it is possible that interviewees stressed their importance thinking of the main trends and changes in the industry (automation, IoT, Big Data, etc.), while survey respondents focused on current needs and used recent vacancies as a guideline. Although it is expected that a larger proportion of workers will be expected to be capable of reading and interpreting complex data in the future as the sector transitions to Industry 4.0, it could be argued that data skills are currently linked to very specific functions.

In relation to managerial skills, a majority of interviewees agreed with the statement that steel workers are now required to undertake more administrative and decision-making tasks than before. With the introduction of lean working, steel companies have been moving towards increasingly flexible organisational structures. "40 years ago, there were at least seven hierarchical levels in a steel factory. Nowadays, it is rare to find more than three"[150]. Many bureaucratic functions that once lied with specific "white collar" profiles have been progressively integrated either into automated processes or in the core functions of managers and unit leaders. This change in company's business models has had a substantial impact on the organisation of the work, which is now relying on small operational teams of technicians and engineers. In this framework, the amount of decision-making that steelworkers are exposed to on a daily basis increased significantly (although, thanks to automated processes, these are rarely complex decisions). Teamwork is acquiring increasing importance, not only among members of a specific team but also among the different teams that follow the products across the different steps of production and commercialisation. As a senior researcher pointed out while describing his experience in the industry:

> "*it was not uncommon to see people working in the sales team with little to no technical background knowledge on the product they were selling (…). I think that a better alignment between units and departments could solve many issues that companies are currently facing*"[151].

Among the lowest-ranking skills, we find soft skills (7%), language skills (5%) and green skills (4%). While several interviewees regarded competencies in sustainability and environmental awareness as a key driver for the evolution of careers in the industry, quantitative data does not appear to reflect the same position (at least when a trade-off is present). A possible reason behind this discrepancy can be found in the fact that interviewees came from industrial, educational and policy environments, whereas the survey focused exclusively on the production side. In addition to that, interviewees were selected among high-level international profiles active in several international initiatives, who are more likely to be aware about the main challenges the sector is facing to reduce CO_2 emissions and meet the EU climate and environmental targets. Another possible

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[148] Temperature adjustment, composition adjustment, deoxidation and desulfurisation processes, thermo-chemical homogenisation, hydrogen and nitrogen removal, decarburisation, etc.
[149] Job notice analysis shows that design and modelling skills are often related to proficiency in 2D and 3D CAD simulation software (e.g. Solidworks, Rhinoceros, Telka, Navisworks, ANSYS and ABAQUS)
[150] Interview notes - Education Providers, Director of a steel-related training and former ECSC official
[151] Interview notes - Education Providers, Senior scientist in material manufacture at Warwick University, former Manager in a steel multinational company

explanation is that soft skills, languages and green skills are not perceived as urgent needs now, but their importance will grow over time. Furthermore, as some industry stakeholders pointed out, specific skillsets, such as digital skills and green skills, may be regarded as an integrant component of other skillsets (e.g. technical) by employers. This would explain why they score lower than other skills when they are considered separately, as it was the case in the survey. For instance, green skills such as energy system integration and knowledge of energy sources may be considered part of the technical skillset of an energy technologist.

With regard to language skills, it should be noted that Survey 1 focused on the ability to understand and communicate in foreign languages. Although this ranked quite low in the survey, this finding may change depending on the country and on the specificities of the occupation. As shown in the National profiles (Annex 7.3), language proficiency is regarded as increasingly important, especially in light of the number of non-native speakers being integrated into the steel-making industry. This is particularly relevant in countries like The Netherlands, where several low-skilled positions are occupied by non-Dutch speaking workers, or Germany, where companies are playing an active role in integrating refugees. In those contexts, language proficiency translates into an occupational safety issue, as workers operating potentially dangerous machines and tools should have a clear understanding of safety rules and regulations. In addition, the majority of the reviewed job ads requires applicants to be proficient in at least two languages, i.e. English and the national language. This does not only concern engineering and management positions, for which proficiency in at least one foreign language is almost always required, but also for more technical positions.

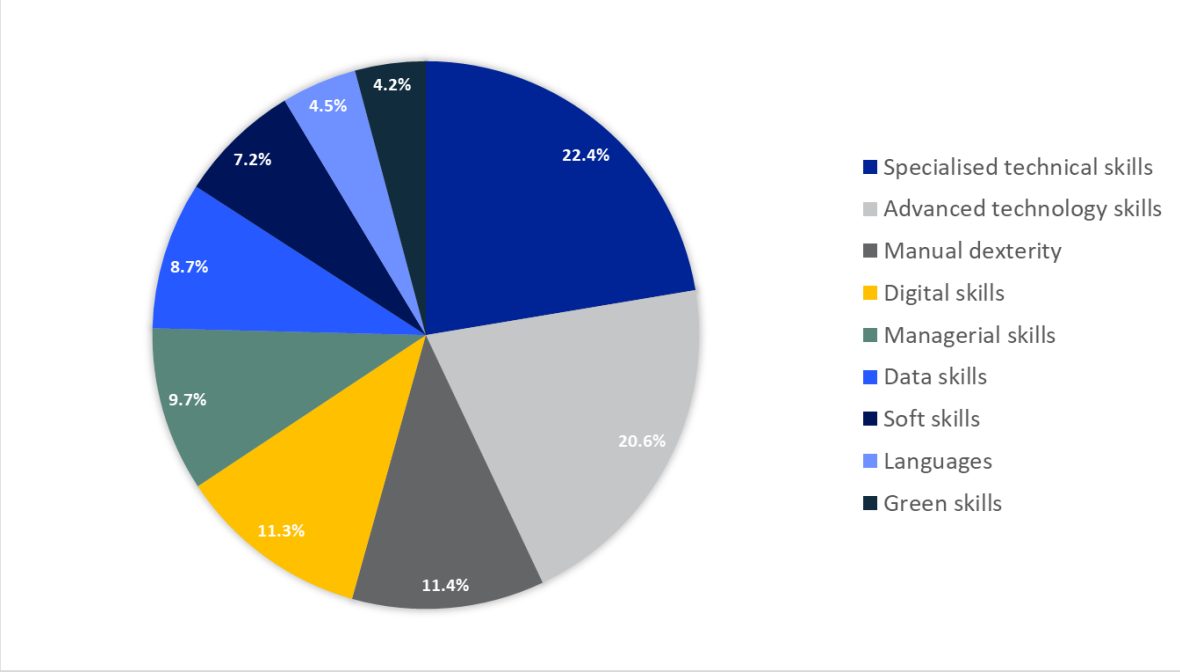

Figure 7 — Survey results - Perceptions regarding the most and least needed skills in steelmaking (industry professionals)

The findings presented in the diagram above are at aggregate level: they provide a robust insight into the preferences of the entire sample. However, it is important to consider that skills needs depend on the specific position that has to be filled. Respondents were asked to consider how important different skills are when they are evaluating candidate profiles, assuming that the candidate has the needed technical and scientific competences (e.g. engineering, chemistry, physics, etc.) and thinking of recent openings or openings the company might have in the near future. It is probable that survey takers based their selection of the most and least important skills for different profiles. These aggregate results can be broken down with the help of advanced analytic methods (Hierarchical Bayes

and latent class). The study team identified five groups. These groups suggest the existence of different priorities in terms of skills needs, as shown in Table 10.

For instance, Group 1 focused more on technical and technological skills combined with digital and data skills. Respondents who are part of this group may have thought of data analysts and IT engineers, who are required in highly automated environments. Instead, it is possible that respondents in Group 2 had operators and technicians in mind: the importance they attribute to manual dexterity is comparatively much higher than in the other groups. Moreover, they also score high in specialised technical skills and advanced technology skills, which are needed to understand advanced machinery and be able to operate it. Group 3 has a more balanced spread of preferences/needs, but sticks out for the relatively higher importance given to green skills and the high score for soft skills and languages. This may correspond to quality and process control profiles who are expected to have good interpersonal skills to manage other people in their team and a horizontal skillset to understand different functions. The importance attributed to green skills may hint at the growing relevance of decarbonisation processes, which have to be implemented to enhance the quality of production in compliance with European standards. As they attribute high importance to both advanced technology skills and specialised technical skills, but also languages and digital skills, survey takers who fall in Group 4 may have focused on researchers who work on process improvement and new steelmaking techniques or on specialised technicians who operate complex (and potentially dangerous) machines. Last, but not least, respondents within Group 5 may have thought of management profiles (e.g. engineers and plant managers), given the high importance they attribute to managerial skills and soft skills, besides specialised technical skills and digital skills.

Table 10 — Groups with different skills needs/preferences

	Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**
Group size	49	65	34	28	20
Managerial skills	3.4	7.5	12.8	8.8	24.1
Data skills	17.0	4.1	12.5	3.2	12.6
Manual dexterity	1.6	24.0	10.6	7.0	1.5
Specialised technical skills	24.6	26.1	8.8	23.9	19.4
Advanced technology skills	25.8	22.9	9.6	26.0	6.4
Digital skills	19.4	5.2	9.5	11.7	14.5
Green skills	3.9	3.0	11.3	2.6	0.9
Soft skills	2.4	6.3	16.0	2.0	17.8
Languages	1.8	0.9	8.7	14.9	2.8

To provide additional depth to the analysis of skills needs, the same question on steel-related skills was asked to the sample students, graduates and jobseekers who took part in Survey 2. The beliefs of this second pool of respondents appear to substantially match the expectations of steel professionals, with specialised technical skills and advanced technology skills still covering the largest part of the diagram (see Figure 8). However, the second group seems to give more importance to manual skills, while digital and data skills are regarded as even less relevant than in Figure 7. These results suggest that, while there is an overall alignment on the core skills needed to work in the industry, steelmaking is still regarded as manual work, with little to do with digital technologies, let alone with the analysis and interpretation of data. This would also be in line with the very low score attributed to languages (3.6%), which may be considered as more relevant for intellectual and/or office jobs. Finally, it is worth mentioning that green skills score a little bit higher among students and jobseekers than they do among industry professionals, which may hint that there is a certain level of awareness regarding the role of the industry in the framework of the decarbonisation processes.

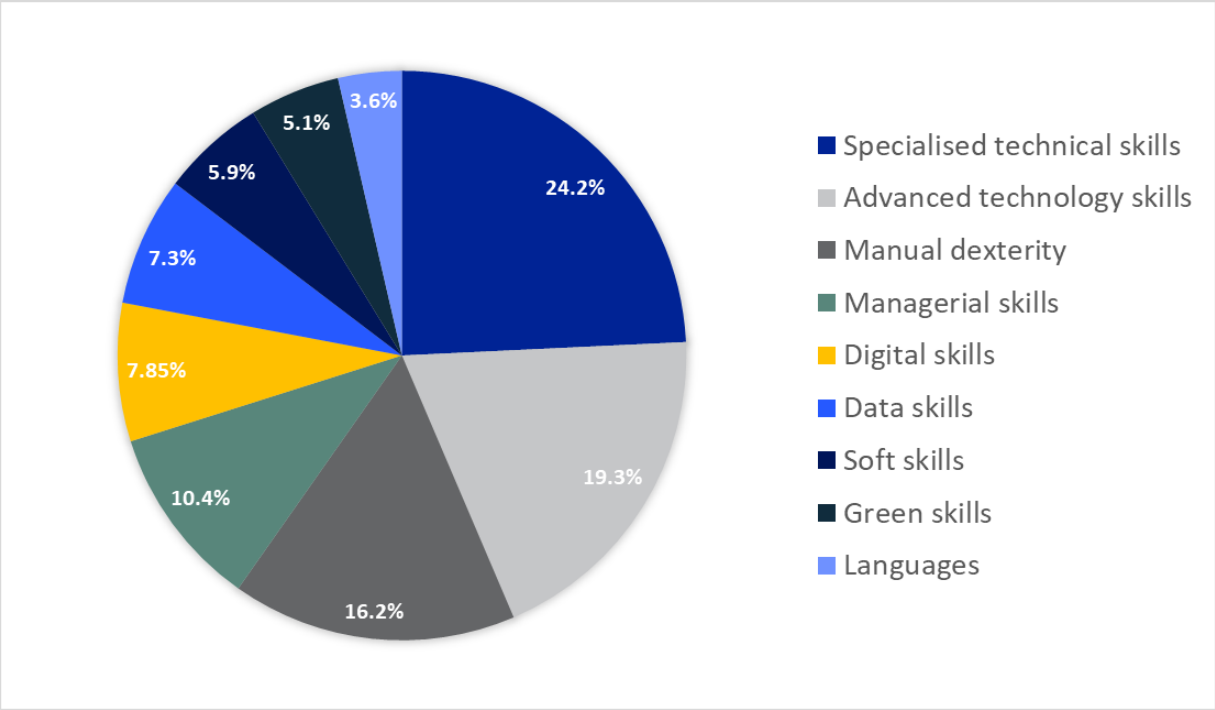

Figure 8 — Survey results - Perceptions regarding the most and least needed skills in steelmaking (students and jobseekers)

From an occupational perspective, interviews with company representatives highlight a strong demand for skilled professionals at different levels, with a strong focus on engineers and skilled production workers. The demands for metallurgical engineers, specialised metallurgists and production area operators remains high, with specific reference to machinists, welders, mechanics and furnace operators. At the same time, the demand for automation engineers and technicians appears to be rising, especially for what concerns machine maintenance, which remains one of the most important challenges faced by the industry (maintenance costs account for a substantial part of plant costs). Additionally, the development of "breakthrough" enabling technologies in the field of cyber physical systems (CPS)[152] is fuelling an increasingly high demand for computer scientists, application managers and ICT managers, who are responsible for ensuring the smooth functioning of AI-driven applications. As several interviewees pointed out, the actual supply of specialised and highly skilled professionals does not match the demands of the industry, which indicates the existence of skills gaps, mismatches or shortages.

4.3.2. Current skills gaps, mismatches, and shortages

As highlighted by Cedefop, manufacturing is among the sectors that are experiencing higher than average recruitment bottlenecks, together with ICT and healthcare. Reported bottlenecks mainly concern machine operators, sales representatives, engineers and technicians, ICT professionals, workers in marketing posts, drivers and office support staff[153]. This also affects the steel industry, which is faced with considerable shortages with regard to the skills outlined in the previous chapter.

Recruitment shortages are linked to four fundamental factors:

1. A general lack of adequate profiles across the European economy (due to the low attractiveness of the sector and because of the lack of steel-specific educational programmes)

[152] Cyber-physical systems define all systems connecting physical objects and processes with information processing objects and processes.
[153] Cedefop, Insights into skills shortages and skill mismatch, 2018, p.39

2. A difficulty to integrate new technologies and processes among site workers, especially when it comes to older employees
3. A strong age gap between the workers that are currently employed and prospective employees, which creates a knowledge transfer issue
4. A lack of investment in training and education from steelmaking companies or a lack of long-term company competence strategies.

Skills gaps, mismatches and shortages trigger the need for up-/reskilling initiatives. The survey for industry stakeholders (Survey 1) was used to determine the elements that drive this need both at company level and for the sector as a whole.

In relation to their company's up-/reskilling needs, respondents were asked to assess four items on a scale from 1 (strongly disagree) to 7 (strongly agree), notably:

- Our current staff has to be upskilled to keep the business competitive
- We need to recruit people with new skills to keep our business competitive
- In the past 12 months it has been difficult to cover our skills needs using our staff
- In the past 12 months it has been difficult to find candidates with the right skills for our vacancies

These four dimensions were integrated in a new variable labelled "Company's need for up-/reskilling" (Cronbach Alpha .699). This new variable captures the different dimensions (including one-year temporal effects) and provides a complex indication of the need for skill-related action in the company. A model was created to test the aspects that significantly affect this variable – i.e. the beliefs, perceptions and characteristics that might have a serious impact on this perceived need for upskilling/reskilling interventions at company level. The final model (R Square .472[154], VIF <1.671) including the variables that were found significant (Sig. <0.05) is presented in the table below.

Table 11 — Regression model for up-/reskilling needs at company level

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.567	.438		1.295	.197
	Q17_4: Skills needed: Specialised technical skills	-.447	.124	-.206	-3.617	.000
	Q20_r1: Skills gaps due to the increased use of digital technologies in steelmaking plants	.161	.045	.214	3.611	.000
	Q20_r5: Skills gaps due to gaps left by the aging workforce who retires	.141	.039	.218	3.659	.000
	Q22_r7: Industry changes belief: There will be a substantial demand for candidates with a higher education degree	.141	.046	.187	3.093	.002
	Q30_r2: Developing coaching or work-pair systems (master-apprentice) to facilitate knowledge transfer	.176	.075	.148	2.331	.021
	Q30_r5: Adopting task rotation systems	.099	.052	.109	1.912	.057
	Sectoral need for skill related initiatives	.209	.082	.183	2.541	.012

a. Dependent Variable: Company's need for up-/reskilling

[154] 47% of the variance in the perception of need for re-/upskilling initiatives at company level is explained by the variables included in the model.

As can be seen in the regression results above, a variety of aspects impact the company's need for up-/reskilling – the type of skills needed, the existence of skills gaps due to the increased use of digital technologies, the aging workforce, the appreciation for specific interventions such as coaching and task rotation, the overall sectoral need for skills-related initiatives. While most of the results are quite straightforward (for instance, the greater the perception of skills gaps due to the use of digital technologies, the bigger the need for skills-related interventions), one result sticks out, namely the negative sign in the coefficients for the need for specialised technical skills. When respondents indicated that there will be a need for specialised technical skills in five years, their company's need for up-/reskilling is significantly lowered.

It should be noted that country of fiscal residence and type of company were not found to have significant effects on "Company's need for up-/reskilling" (sig 0.280 and sig .723 respectively).

To assess skills needs at sectoral level, six different items were used to capture multiple aspects that together indicate the need for interventions, notably:

- Q29_1: There is a need for training to manage worker behaviours to improve performance (e.g. efficiency, productivity)
- Q29_2: Upskilling initiatives in the steel industry are needed to meet the requirements of Industry 4.0
- Q29_3: There is a need for greater investments in upskilling initiatives in the steel industry
- Q29_4: There is a need for a more supportive policy framework to facilitate upskilling in the steel sector
- Q29_5: There is a need to update the educational offer for steelmaking profiles
- Q29_r6: Businesses should contribute to the transition from education/training to the workplace to get more people with the right skills

A new variable called "sectoral need for skills-related initiatives" was created out of these items (Cronbach Alpha: .837). The study developed a model to test which elements (beliefs, perceptions, characteristics) play a significant role in shaping this perceived need. Simply put, it aimed to explore which aspects about steel careers and skills gaps increases (or reduces) this perceived sectoral need for intervention. The final model is presented below (R Square .605[155], VIF<1.209).

Table 12 — Determinants of up-/reskilling needs at sectoral level

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.359	.333		1.079	.282
	Q20_r4: Skills gaps due to ineffective knowledge transfer	.140	.030	.242	4.712	.000
	Q20_r6: Skills gaps due to lack of suitable educational programmes	.140	.031	.231	4.473	.000

[155] 60% of variance in the perception of need for re-/upskilling initiatives at sectoral level is explained by the variables included in the model.

Q22_r6: Industry changes belief. New production methods will be used to limit energy consumption	.246	.040	.307	6.075	.000
Q30_r2: Developing coaching or work-pair systems (master-apprentice) to facilitate knowledge transfer	.180	.053	.176	3.373	.001
Q30_r3: Offering regular formal training to the workforce	.226	.052	.225	4.394	.000
Q30_r8: Partnering with education providers at various level to help them develop industry-based courses	.168	.051	.164	3.263	.001
Q7: How many years of experience do you have providing training for the steel industry?	-.015	.008	-.097	-1.992	.048

a. Dependent Variable: Sectoral need for skill related initiatives

As can be seen in the regression results table above, a number of factors have a statistically significant effect (Sig. <0.05) on the sectoral need for up-/reskilling initiatives. For example, the higher the perception of skills gaps, the higher the need for up-/reskilling interventions. The stronger the agreement with the idea that new production methods will be used to limit energy consumption, the bigger the need for up-/reskilling. These factors are wide in nature – perceptions of skill gaps, beliefs about industry changes but also potential remedies to skills needs – signalling a multi-layered structure behind the perceived need for intervention. Interestingly, the respondent's training experience in the steel sector (in years) is found to have a marginally significant negative effect. This means that the more experienced a respondent, the smaller the perceived sectoral need for skills-related initiatives.

Also in this case, the country of fiscal residence and type of company were not found to have significant effects on the sectoral need for skill related initiatives (sig 0.469 and sig .626 respectively).

Despite some differences, both models presented above suggest that the (perceived) existence of skills gaps has a non-negligible effect on sectoral and company's needs for up-/reskilling. Therefore, the study also investigated the possible factors that drive the (perceived) existence of skills gaps.

According to several interviewees from industry and academia, skills gaps come largely from early stages of education. Low student enrolment in STEM curricula has been identified as one of the main factors explaining the occupational shortages in the industry. The demand for STEM skills, especially with regard to ICT, engineering and technical positions is expected to increase substantially over the next years in response to the pivotal role of these profiles in new technological and economic developments. Conversely, the number of graduates in such disciplines is reportedly too low to cater to the needs of the steelmaking industry.

A recent study by the European Commission shows that there are no overall quantitative shortages in the supply of STEM skills. However, shortages may concern specific profiles (e.g. lower female participation in STEM subjects) and also emerge in particular sectors, especially in European regions with a particular concentration of knowledge-intensive companies. Metal manufacturing is one of those. Available data show that at aggregate level, the share of STEM graduates in the EU amounted to 19% of total graduates in 2012 (in comparison, the share of STEM graduates in the US was 14.6% in the same period)[156]. Looking at a breakdown by field of study, however, it emerges that graduates in

[156] European Commission, Directorate-General for Education and Culture, *Does the EU need more STEM-graduates? - Final Report*, 2015

manufacturing and processing rank particularly low, along with graduates in mathematics and statistics, computing and physical science (see Figure 9).

This largely reflects the declarations of several interviewees, who argue that even when students decide to study STEM disciplines, too few choose to specialise in metallurgy and material science. Furthermore, even when graduating in non-core STEM sectors which would still be relevant to steelmaking (e.g. computer science, software development, automation, robotics, etc.), students tend to choose other sectors that are considered more attractive. This largely comes back to the image problem of the steelmaking industry that was detailed in Chapter 4.2. There is still a widespread lack of awareness on the career opportunities offered by the steel sector, and specialised profiles tend to prefer careers in sectors that are seen as having better salaries, more comfortable working environments and higher growth prospects such as ICT services, banking, finance and insurance, and professional services[157]. This trend is further reinforced by the cyclical fluctuations of the steel sector and the continuous mergers and acquisitions of steel companies (often accompanied by mass layoffs and redundancies), which negatively impact the overall image of steelmaking as a source of stable jobs.

It should be noted, however, that many interviewees argued that the shortage of talents appears to affect national and local companies more heavily, as international corporates rely on in-house training centres to up-/reskill their workers and can leverage a strong global presence to find the right candidates for specific positions (see Chapter 4.4).

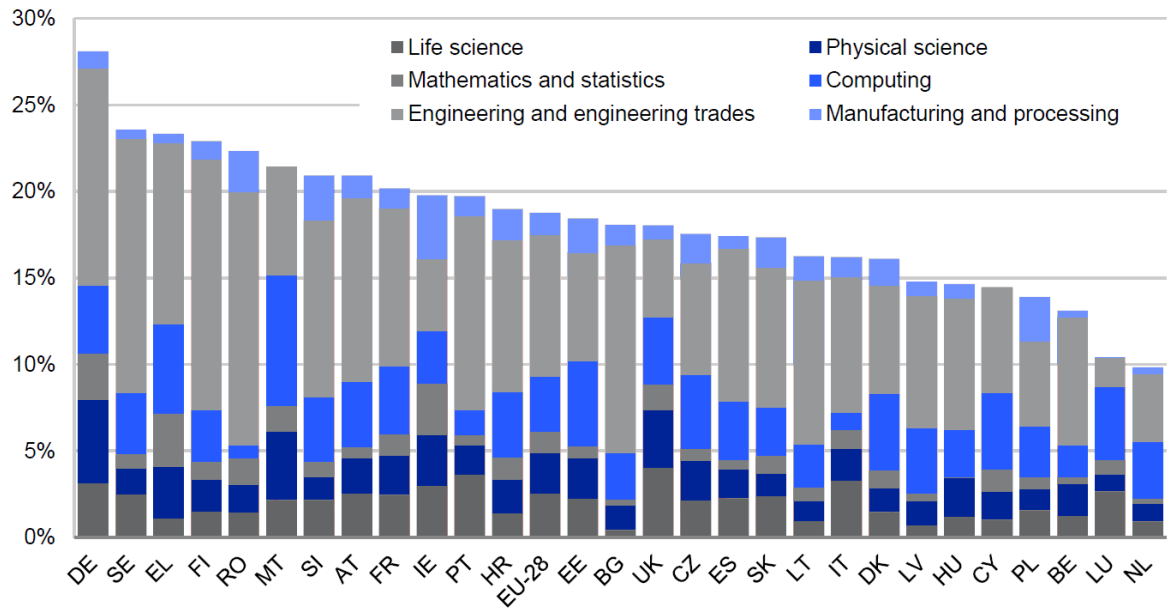

Figure 9 — STEM graduates as% of total graduates, breakdown by field of study, 2014[158]

Several steel producers have also experienced challenges in training their current workforce. The average age in the industry is comparatively higher than the European average, and this reportedly has effects on the employees' ability to integrate skills and competencies that are usually more common in younger individuals. A good example is digital skills. As reported by the HR director of a major German steel producer, they are experiencing difficulties in training older workers to use digital technologies, whereas younger workers already have a good proficiency in using computers and other digital tools in their daily work. Another interviewee from an advanced steel research centre noted that,

[157] Cedefop, "Skills panorama - Future Jobs", https://skillspanorama.cedefop.europa.eu/en/skills-themes/future-jobs, Last visited on 05.06.2019

[158] STEM for Youth, Deliverable Report - D2.1 Report on Employment Labour Market Trend in EU, December 2017, p.61 (Note: observation for France dates to 2011)

especially in production areas, workers struggle to integrate new technologies and handle them autonomously[159]. Therefore, it is not uncommon for the R&D technicians that developed said technologies to end up working as supervisors and consultants at the production site (the interviewee provided the example of a production area sensor system developed in the company where he/she was employed) [160].

Some company and trade union representatives also argued that another challenge to reskilling the current workforce relates to the lack of a continuous learning culture. Especially in older workers, this can lead to a certain resistance to both change and the flexible approach to tasks and responsibilities that is required under high-performance working models. Learning culture and sensitivity towards specific themes is widely affected by the role that workers cover within the company. In other words, "(…) a specialised technician or engineer is more likely to be sensitive to the impact of trends like digitalisation and Industry 4.0 than a crane operator or a forklift worker"[161]. Not all workers have the preparation to understand the latest technological evolutions, especially those covering mechanical and manual positions. "Without a structured intervention at company and trade union levels, there is a risk to further increase the already existing imbalances in the level of preparation across the workforce"[162].

As highlighted in the latest-available OECD statistics, firm-based training is offered more to high- and medium-skilled workers. In the countries included in the figure below, on average between 30% and 76% of workers are provided with training by their companies. If we consider the seven Member States analysed in this study (Finland, France, Germany, Italy, the Netherlands, Poland and Spain), the average of workers receiving in-firm training is 55%, with Finland and the Netherlands having the highest rates (76% of the total workforce receive training), and Italy the lowest ones (40% of the total workforce receives training). On average, among workers who receive in-firm training, less than a quarter are low-skilled[163].While these workers might receive informal training or learn on the job, they seem to be less exposed to formal training.

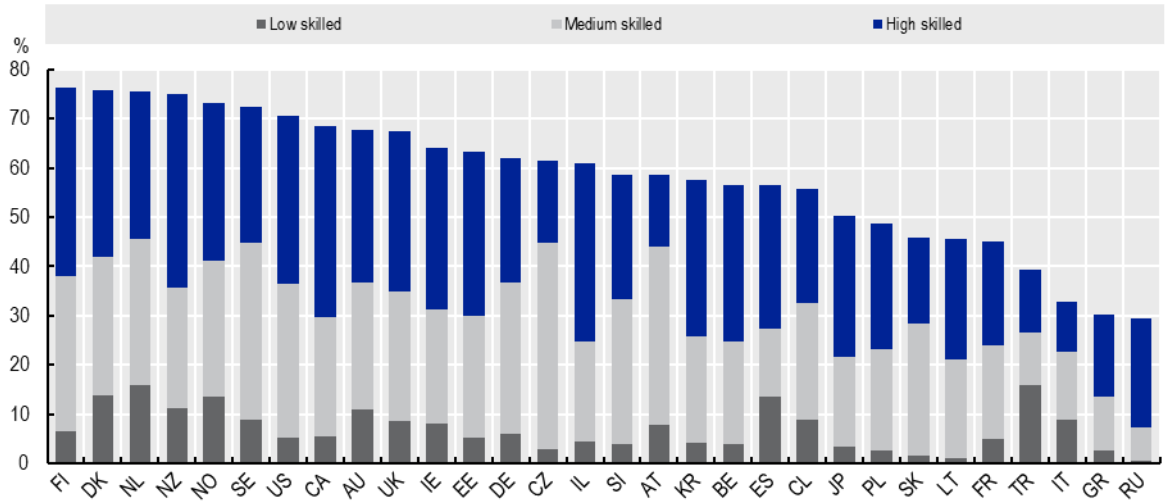

Figure 10 — Workers receiving in-firm training, by skills level (2012 or 2015)[164]

[159] Interview notes - Industry Stakeholders, HR director at thyssenkrupp
[160] Interview notes - Education Providers, Senior scientist in material manufacture at Warwick University, former Manager in a steel multinational company
[161] Interview notes - Workers Organisations, Senior representative of a national metalworkers' union
[162] Interview notes - Workers Organisations, Senior representative of a national metalworkers' union
[163] OECD, OECD Science, Technology and Industry Scoreboard 2017 - The Digital Transformation, OECD Publishing, Paris, 2017, p.45
[164] Ibid.

The results from the survey with industry stakeholders (Survey 1) offer a further confirmation concerning some of the key factors causing skills gaps. Participants were asked two questions (Likert scale 1-5):

- How big do you think skills gaps in the steel sector currently are?
- How big do you think skills gaps in the steel sector will be in 5 years?

The reliability test suggested that these questions do not belong to the same overarching scale, which could also signal that they stand quite "far" from each other. Hence, two separate models were used to determine impact of potential factors associated with skill gaps. The first model tested ten different potential factors against the perception of current gaps in the skill sector (R Square .202[165]). The results in the table below show that three of the ten possible explanations have a statistically significant result on the current skill gaps overall perception – the increased use of digital technologies, the lack of suitable educational programmes, and the delays in training provision after the introduction of a technological innovation.

Table 13 — Determinants of the perception of current skills gaps

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.698	.266		6.392	.000
	Q20_r1: Skills gaps due to the increased use of digital technologies in steelmaking plants	**.103**	**.042**	**.214**	**2.455**	**.015**
	Q20_r2: Skills gaps due to the growing automation of processes	-.048	.043	-.095	-1.111	.268
	Q20_r3: Skills gaps due to the need to comply with greening policies at EU level	-.016	.030	-.037	-.517	.605
	Q20_r4: Skills gaps due to ineffective knowledge transfer	.056	.034	.128	1.639	.103
	Q20_r5: Skills gaps due to gaps left by the aging workforce who retires	.009	.035	.022	.255	.799
	Q20_r6: Skills gaps due to lack of suitable educational programmes	**.091**	**.037**	**.199**	**2.463**	**.015**
	Q20_r7: Skills gaps due to time-lags between the introduction of a technological innovation and the provision of training	**.114**	**.042**	**.219**	**2.731**	**.007**
	Q20_r8: Skills gaps due to unfulfilled candidates' salary expectations	-.029	.033	-.070	-.876	.382
	Q20_r9: Skills gaps due to competition by non-EU countries	.017	.030	.041	.575	.566
	Q20_r10: Skills gaps due to companies' lack of skill forecasting methods	-.011	.040	-.022	-.270	.787

a. Dependent Variable: How big do you think skills gaps in the steel sector currently are?

[165] 20% of the variance in the perceived existence of current skills gaps is explained by the model.

The same model tested on future skill gaps (R Square .141[166]) revealed one different factor having statistical significance, as illustrated in the table below. Besides the gap between the introduction of an innovation and the corresponding training, future skills gaps are affected by the retirement of older workers.

Table 14 — Determinants of the perception of future skills gaps

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.251	.394		3.173	.002
	Q20_r1: Skills gaps due to the increased use of digital technologies in steelmaking plants	.078	.062	.114	1.256	.211
	Q20_r2: Skills gaps due to the growing automation of processes	.061	.064	.086	.964	.336
	Q20_r3: Skills gaps due to the need to comply with greening policies at EU level	.042	.045	.071	.947	.345
	Q20_r4: Skills gaps due to ineffective knowledge transfer	-.028	.050	-.045	-.552	.582
	Q20_r5: Skills gaps due to gaps left by the aging workforce who retires	**.122**	**.053**	**.204**	**2.320**	**.021**
	Q20_r6: Skills gaps due to lack of suitable educational programmes	.012	.055	.018	.220	.826
	Q20_r7: Skills gaps due to time-lags between the introduction of a technological innovation and the provision of training	**.133**	**.062**	**.177**	**2.134**	**.034**
	Q20_r8: Skills gaps due to unfulfilled candidates' salary expectations	-.015	.050	-.024	-.297	.767
	Q20_r9: Skills gaps due to competition by non-EU countries	.009	.045	.015	.209	.834
	Q20_r10: Skills gaps due to companies' lack of skill forecasting methods	-.015	.059	-.021	-.249	.804

a. Dependent Variable: Q19: How big do you think skills gaps in the steel sector will be in 5 years?

A great challenge regarding the ageing workforce is related to knowledge transfer. In most cases, job-specific competencies are acquired by workers inside the company. According to the OECD, training of workers mostly happens on the job[167]. Although in-firm training plays a significant part in this process, the vast majority of interviewees agree that knowledge acquisition in the industry heavily relies on on-the-job informal education, more specifically knowledge transfer between older and younger generations of workers. Company representatives tend to agree that the required practical knowledge for students from vocational and HE backgrounds cannot be acquired only by courses or training. Technical know-how is passed down through direct mentorship on the job. As many pointed out, mentorship is equally important for younger and older workers: for the former, it

[166] 14% of the variance in the perceived existence of current skills gaps is explained by the model.
[167] Ibid., p.110

represents a valuable way to acquire a technical know-how that they would not be able to acquire through theory alone; for the latter, being able to pass down their knowledge is a form of empowerment and recognition of their value within the company.

However, the low numbers of young people entering the industry and the increasing age of steel workers are creating a gap in knowledge transfer.

> "*Sometimes it seems that there is still too much knowledge lost when employees leave the company. They are experts in their fields and their valuable knowledge is often concentrated just on them*[168]".

Overall, interviewees agreed in saying that the steelmaking workforce is rapidly ageing, and older workers have already started retiring. These are highly experienced workers, who possess invaluable technical know-how that risks disappearing with their retirement. This is a considerable loss for employers, as recreating knowledge lost can be lengthy and entails substantial costs.

Another element adding to the already complex issue of knowledge transfer is that many tasks across the production area cannot be performed by large numbers of people. Some of them can be performed by a maximum of two workers. In these cases, knowledge transfer cannot be achieved through general training, and one-to-one mentoring still appears to be the most effective solution.

According to the European Commission 2013 Action Plan, "the age structure in most European steel-producing companies is such that more than 20% of the actual workforce will have left the industry in the period 2005-2015, and close to 30% will leave up to 2025"[169]. In Germany, the average age of the steel workforce is 44, whereas ArcelorMittal Poland states that most of its workforce is over 50. In the Netherlands, the average age of Tata Steel Europe's workers is 45, with over one third of the workforce over 50[170]. Conversely, Italy appears to benefit from a comparatively younger workforce, with an average age of 35[171]. At the same time, the industry is facing increasing challenges in attracting young talents, who turn to more attractive sectors.

This precarious situation is further aggravated by mass layoffs and early retirements, which are common in the industry. One clear example was provided by a representative of one of the major metalworkers' union in the UK, who commented on the closure of the British Steel Pension Scheme (BSPS) in 2017. Following the closure of the BSPS, an estimated 8,000 people transferred to other schemes, including the newly created BSPS2 and the Pension Protection Fund (both were less generous than the previous scheme). A portion of workers decided to transfer out of the scheme altogether and subscribe to private pensions. The most notable effect was that workers could now retire at the age of 55-60, without being obliged to give prior notice. As a consequence of these redundancies, many early retirees were replaced by younger apprentices, thus lowering the average age in the British steel industry. New apprentices, however, entered the industry without always receiving an adequate knowledge transfer from those who were there before them.

Many industry and trade union representatives called for a structured planning to tackle the transition between the older and younger generation of workers. Addressing the loss of technical know-how has been identified as a key priority of company training, which many interviewees still consider to be inadequate to face the challenges of the industry. A more systematic approach to knowledge transfer is also considered important to avoid the transfer of bad practices (for instance, regarding health and safety measures) and to facilitate so-called reverse mentorship. Since young people bring in valuable skills in their own right that they can share with their more senior colleagues, particularly in terms of

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[168] Interview notes - Industry Stakeholders, Head of HR Development of a multinational steel producer
[169] European Commission, "Action Plan for a Competitive and Sustainable Steel Industry in Europe", COM(2013) 407 final, European Commission, Brussels, 11.06.2013, p. 21
[170] Tata Steel Europe, Sustainability Report 2018, 2018, p. 10
[171] For further details, see National profiles

digital skills, green skills or knowledge of health and safety practices, knowledge transfer should be a two-way process.

According to the available data, European steel companies provide employees with an average of 28 hours of training a year[172]. In Northern Europe and France, the average is around 32 hours per year, whereas in Italy,[173] Poland and Spain it is closer to 26 hours. The largest part of training hours is devoted to safety and health, whereas a smaller portion focuses on sustainability and recycling. In the last two years, several companies reported an increase in training that targets new technologies and innovation. In Italy, for example, Federacciai reports that training hours dedicated to topics different from "Environment and Safety" rose from 21 to 50% of total training hours between 2013 and 2016[174]. Comparatively, the amount of training time devoted to segments such a digitalisation, IoT, and innovation management appears to become more substantial.

Many interviewees still find that the training programme of European companies is lagging behind, especially when it is compared to the requirements of HR managers and recruiters for new hires. Even when training is organised, it may actually not be completed because of priorities in production processes that prevent staff from being released for the duration of the training[175]. Furthermore, one interviewee stated that "(…) companies tend to provide workers, especially production workers, with the skills to perform specific tasks"[176], without building the flexible profiles that they claim to need when recruiting new personnel. In essence, while companies require people with highly transferable skillsets, the building of the latter does not appear to take priority when training their own personnel. This consideration is corroborated by the interviews conducted with many local and national trade union representatives, who identify the root cause of skills gaps as low company investments in training or in investments targeting only specific roles, or even very specialised profiles due to the lack of a forward-looking competence strategy based on accurate forecasts. For instance, for 9 initiatives reported upon in the questionnaire for authorities, no method was used to assess competences and skills needs in the steel industry 12 months before the launch of the initiative. Furthermore, 85% of respondents to Survey 1 (industry stakeholders) declared to have no method to anticipate skills needs. This further reinforces the imbalance in development opportunities between high- and low-skilled workers.

The lack of an adequate strategy to personnel selection, training and development appears to be particularly prominent for smaller companies, whose priority remains increasing the level of production. In Italy, for instance, where the steelmaking landscape is dominated by medium-sized regional groups, the issue of training seems to be particularly pressing. As one interviewee from an organisation specialising in trainings for the steel industry mentioned:

> "*Up-/reskilling workers takes time, and companies are under considerable pressure to maintain their production levels. As a result, many of them privilege short-medium term economic performance over long-term investments in training*"[177].

Some survey respondents from the industry identified a factor influencing skills gaps in matters related to discrimination based on gender or race. This is reported to occur

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[172] Estimate based on the yearly training hours provided by the following companies: ArcelorMittal Poland (27 hours), ArcelorMittal Spain (28 hours), ArcelorMittal France (31 hours), Tata Steel Europe (32.6 hours), Voestalpine (22 hours). The data has been retrieved from the annual report of each company, c.f. bibliography.

[173] For Italy, data has been retrieved based on an estimate made by Federacciai on 14 of its members (Federacciai, Rapporto di sostenibilità 2017, 2017, p.101)

[174] Federacciai, Rapporto di sostenibilità 2017, 2017, p. 101

[175] Stroud, D., An evaluation of the basics of gas combustion training (Report No. 3206), Centre for Global Labour Research, Cardiff University, 2010 (confidential)

[176] Interview notes - Education Providers, Senior scientist in material manufacture at Warwick University, former Manager in a steel multinational company

[177] Interview notes - Education Providers, Senior representative at Riconversider

especially at the upper echelons of companies. For instance, the number of female workers is still considered to be insufficient to close the gender gap in spite of the fact that managerial positions involve less manual work, which is widely indicated as the main factor discouraging women from entering the industry.

Overall, the skills gaps appear to be driven by two fundamental trends. On the one hand, the occupational structure of the steelmaking industry has evolved in such a way that over the past 30 years, it "(…) changed demand for labour with relatively modest educational skills to demand for labour with higher levels of qualifications and skills[178]". These include:

- a strong technical background, ranging from engineering and material science to (big) data analysis, and advanced analytical skills (depending on the specific professional profiles);
- a horizontal skillset, including soft skills such as management, teamwork, flexibility and autonomous problem-solving, but also basic ICT skills;
- market-oriented skills and a more informed overview of the steps leading the steel products from creation to market rollout.

The European steel industry is faced with several problems not only in finding the right profiles to fill vacant positions, but also in training its current workforce to meet the standards it needs to stay competitive. In addition to that, the ageing steelworker population coupled with a poor staff turnover is further aggravated by low numbers of trained young individuals entering the market, thus creating a considerable generational gap. Furthermore, European steelmaking appears to be affected by a poor learning culture. This consideration goes both ways for managers and employees: while there are still many companies that consider training as a cost rather than an investment, there are also low-skilled employees who are unwilling to upskill/reskill themselves. Fear of change and delays in adaptation are still very much felt as one of the main causes for current skills gaps, especially regarding new trends such as digitalisation and robotics.

4.3.3. Expectations for the future: new skills and drivers of change

The global steel industry, like many other manufacturing sectors, is undergoing a transformation towards an increased human-machine interaction. This transformation is best summarised with the concept of "Industry 4.0". Due to its pervasiveness, the term received several interpretations. One possible definition of what is generally considered as the driver behind the fourth Industrial Revolution is a progressive "integration of a set of technologies that enable ecosystems of intelligent, autonomous as well as decentralised factories and integrated product-services"[179]. Following the conceptualisation of Ittarmann and Niehaus, the idea of Industry 4.0 translates into a "technology-induced and -centred vision of future automation and virtualisation of industrial production systems"[180]. As the definition suggests, Industry 4.0 is characterised by the integration of a multitude of breakthrough innovations in process automation, which are linked to the advances in ICT and the increasing operationalisation of the IoT. Concrete examples linked to steelmaking include, among others, CPS, Big Data analytics and Decentralised Control Systems. The figure below provides a high-level overview of the concepts and trends that can be grouped under "Industry 4.0" (see Annex 7.4 for a contextualisation of Industry 4.0 and the breakdown of the Industry 4.0 concepts in sub-categories).

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[178] European Commission - Directorate-General for Enterprises and Industry, Study on the Competitiveness of the European Steel Sector - Final report, August 2008, Ecorys SCS Group, Rotterdam, 2008, p. 91

[179] Santos, C., Mehrsai, A., Barros, A. C., Araújo, M., Ares, E., "Towards Industry 4.0: an overview of European strategic roadmaps", paper prepared for the Manufacturing Engineering Society International Conference 2017, MESIC 2017, 28-30 June 2017, Vigo (Pontevedra), Spain

[180] Ittermann, P., & Niehaus, J., "Industrie 4.0 und Wandel von Industriearbeit: Überblick über Forschungsstand und Trendbestimmungen", in H. Hirsch-Kreinsen, J. Niehaus, & P. Ittermann (Eds.), Digitalisierung industrieller Arbeit: Die Vision Industrie 4.0 und ihre sozialen Herausforderungen, 2nd ed., pp. 33–51, Nomos Verlagsgesellschaft mbH & Co. KG, Baden Baden, 2018

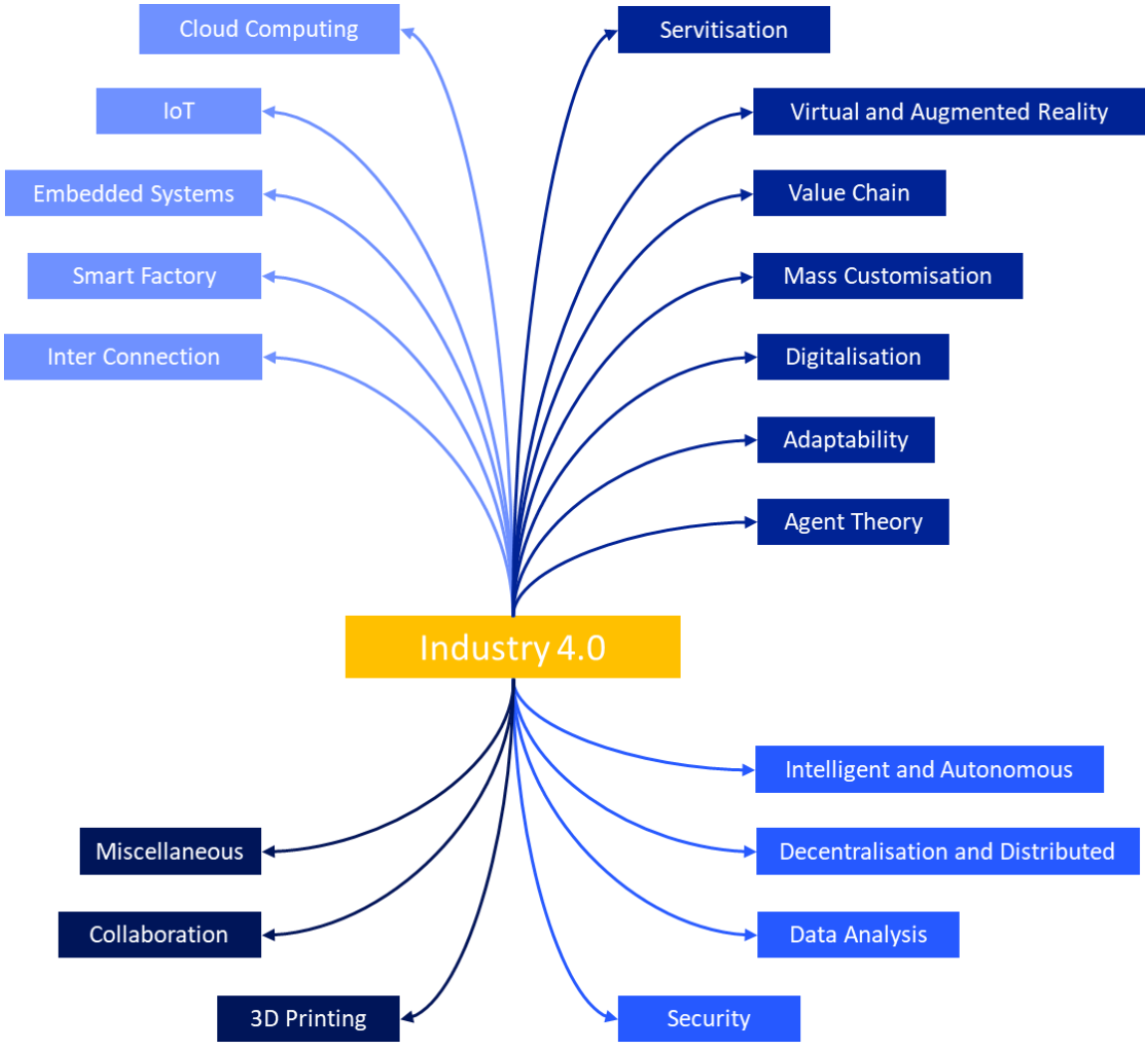

Figure 11 — An overview of Industry 4.0 concepts[181]

Industry 4.0 is expected to substantially reduce the complexity of industry operations while increasing their efficiency and reducing costs across the whole value chain. According to Santos et al., the main paradigm shifts that are expected to occur can be broken down into four core areas[182]:

1. **Factory and Nature**: The optimisation of industrial processes will bring substantial improvements in resource efficiency and sustainability. This is particularly relevant to the European steel industry, especially with regard to the efforts undertaken to reduce CO_2 emissions and meet the EU climate and environmental targets for 2050.
2. **Factory and Local communities**: The decentralisation of production processes will enable companies to localise their products to best suit a particular market and better integrate customers in product design[183]. This is expected to increase customer acceptance and strengthen ties with local communities.

[181] Santos, C., Mehrsai, A., Barros, A. C., Araújo, M., Ares, E., "Towards Industry 4.0: an overview of European strategic roadmaps", paper prepared for the Manufacturing Engineering Society International Conference 2017, MESIC 2017, 28-30 June 2017, Vigo (Pontevedra), Spain
[182] Ibid.
[183] World Economic Forum, "Localized microfactories - the new face of globalised manufacturing", 11.06.2019 See: https://www.weforum.org/agenda/2019/06/localized-micro-factories-entrepreneurs-and-consumers/, Last visited on 12.06.2019

3. **Factory and Value chains**: The disruption of value chains is expected to make the manufacturing process more adaptable and responsive, therefore enabling a stronger customisation of products and services[184].
4. **Factory and Humans**: Industry 4.0 is grounded on the concept of a human-oriented automation of production processes. In other words, the human-machine interaction is expected to increase growth while improving work conditions (automation is already a key enabler in steel production chains, with a significant reduction of manual labour and physical stress).

To gain a clearer view of how Industry 4.0 fits into the evolution of the steel industry, one can refer to the x.0 scheme provided by Zeman[185]:

- Steelwork 1.0: From handcraft steelwork to industrial steel work
- Steelwork 2.0: The use of electric energy and electric motors (easier material logistics)
- Steelwork 3.0: Applying machines with numeric control (since 1970s)
- Steelwork 4.0: Vision of a self-acting union of assets without human workforce (for the welfare of humans)

The same author points out that the steel industry is currently midway between Steelwork 3.0 and Steelwork 4.0. Although the areas of intervention of this fourth industrial revolution are becoming clearer, and concrete applications of Industry 4.0 to key aspects of steelmaking are already being studied (e.g. integrated sensors for predictive maintenance and quality management, digital optimisation of logistics and stock management, improved organisational safety and health), Industry 4.0 is far from being a fully adaptable and integrated concept, and largely remains bound to the future of steelmaking. It is still largely unclear how the advent of Industry 4.0 will shape the tasks that steelworkers will be required to perform. Therefore, it is difficult to pinpoint the specific skill sets that the industry will try to integrate.

The European steel industry has become more capital intensive over the years, with a considerable increase in labour productivity. This trend is likely to intensify in the future, as steel plants are able to maintain and increase production levels with less and less labour. According to a recent report on AI, manufacturing will be impacted heavily by automation. An illustrative example can be found in the use of industrial robots. Over the last 25 years, the manufacturing industry has been among the main users of physical robots. Over 50% of industrial robots in manufacturing are used in the automotive sector, with the rubber and plastic and metal industry following with around 10% each. Industrial robots are generally used to perform repetitive, precise, and potentially dangerous tasks. In steelmaking, these can include metal cutting or surface finishing operations. However, the increased versatility of robots and machines for handling more complex tasks will inevitably impact the amount of low-skill jobs at risk from increasing automation[186].

Although the pace at which digitalisation will cause job losses may be overstated[187], many interviewees from the industry agreed that the contraction of the steel labour market will lead to a progressive disappearance of low-skill jobs required for routine tasks, while the demand for highly skilled labour will increase. Despite the expected reduction in labour, it should be noted that production workers will still make up for the vast majority of the workers hired in a steel company (interviewees estimate that 70% of the current workforce are blue-collar workers) and are expected to play an important role in the industry of the future. The first positions incurring the greater risk of automation are mainly linked to administrative functions. Concerning operators, the main change in production area will

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[184] A study led by Deloitte on a sample of 1,560 adults in England, Scotland and Wales shows one in three consumers feels like standard products or services do not meet their expectations. Cf. Deloitte, The Deloitte Consumer Review - Made-to-order: The rise of mass personalisation, 2019

[185] Zeman, P., "Industrie und Stahlbau 4.0 - ein paar Gedanken!", Stahlbau 86(1), 84–86, 2017, p. 85

[186] European Commission, AI: The Future of Work? Work of the Future!, 2019

[187] Lloyd, C. and Payne, J., "Rethinking country effects: Robotics, AI and work futures in Norway and the UK", in New Technology, Work and Employment, 34(3): 208-225, 2019

occur at the level of competences, as they will be required to develop varied and adaptable skillsets.

The T-shaped skills concept mentioned in Chapter 4.3.1 becomes even more relevant here. What emerges clearly from the interviews is that the notion of specialised profiles goes beyond the idea of being capable of performing a very specialised task. While more leading profiles are expected to be needed in engineering and technician positions, with a specific focus on data analysis, supply chain management, and maintenance, the majority of the stakeholders involved in this study mentioned "flexibility" and "adaptability" as the key trait that steelworkers of tomorrow will need to integrate into their skillset.

A conference paper presented in 2015 by the Association of German Engineers (Verein Deutscher Ingenieure – VDI) and the American Society of Mechanical Engineering (ASME) tried to imagine the key characteristics of the future manufacturing worker. In doing so, the research group developed a pyramid model composed of three tiers: the third tier made up the basis for the second tier, which in turn supported the first tier. Although the model was developed to describe the future situation of industry workers in Germany and the US, the structure can serve as a basis to describe the findings of the present study. Interestingly enough, the forecasts made by VDI and ASME, which were based on the professional experience of the authors, largely reflect the results of our research, especially those stemming from primary data collection, i.e. interviews and surveys[188].

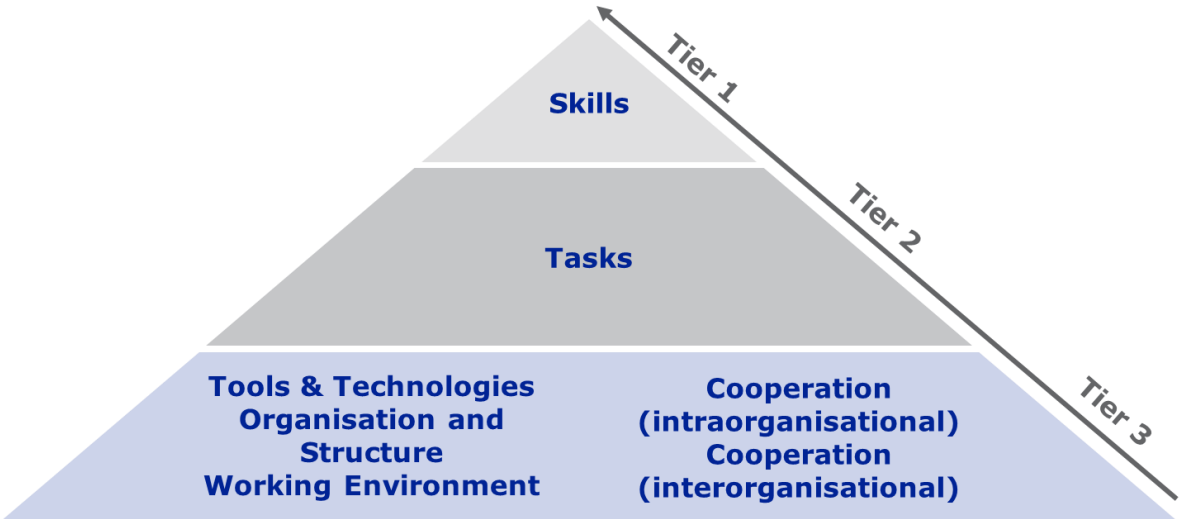

Figure 12 — Deriving future skills: 3-Tier structure[189]

Tier 3, which is the basis of this model, contains the key exogenous factors that are expected to change in a steel company. These factors will affect the tasks that steel professionals will be required to perform, which in turn will influence the skills required to perform these tasks.

- **Tools & Technologies** – Automation and smart devices will increase the amount of real-time information available in the production area, allowing workers to make more informed decisions in short timespans to deal with complex situations. Predictive sensing technologies, for example, are expected to allow workers to determine causal factors of potential issues and devise corrective actions at almost all phases of production (casting, strip mill, rolling, etc.). The advances in robotics will allow collaborative robots to become more and more autonomous and relieve

[188] Whereas, when defining "future", Gehrke et al. refer to an indefinite point in time where Industry 4.0 has become a fully-fledged reality, our forecast is based on a time horizon of five years. Therefore, we try to define what a steelwork on its way to become "Steelwork 4.0 will look like in 2024-2025

[189] Gehrke, L. et al., A Discussion of Qualifications and Skills in the Factory of the Future: A German and American Perspective, 2015, pp. 8-13

workers from simple and repetitive tasks. At the same time, human intervention will become more important in the maintenance and supervision of machines.

- **Organisation & Structure –** Changes in the organisational structure of steel companies have been widely anticipated in literature, and primary data collection confirm the forecasts. As CPSs become more automated, there will be a general flattening of hierarchical structures, with a progressive decentralisation of decision-making. "The integration of early artificial intelligence tools is also causing organisations to become more collaborative and team-oriented, as opposed to the traditional top-down hierarchal structures"[190]. Decisions will rest with small and agile teams of operators led by high-skilled engineers.
- **Working Environment** – In 2015, Gehrke et al imagined the working environment of the factory of the future as "an open and creative space, similar to what technology companies, such as Apple and Google, have today. Young engineers perceive it to be very clean, bright, and a nice place to be and work for both men and women"[191]. Although this generalisation cannot be applied to all steel companies, many of them have invested heavily in modernising their infrastructure, to a point where the actual working conditions differ substantially from the general perception (as detailed in Chapter 4.2.1). With an already high degree of automation, many steel plants are state-of-the-art facilities, with little to no human intervention on the casting line. The concentration of human resources is in the control room, where operators coordinate the various operations of the plant (preparation of the ores, smelting, casting, finishing, etc.). Furthermore, the advances in technology might also favour scenarios where operators will be able to supervise production remotely. This would bring substantial changes in the shift models and would enable trends towards home office working.
- **Intraorganisational and Interorganisational Cooperation –** Interconnectedness under Industry 4.0 will not only affect the communication between machines and human-machine interactions, it will also modify the way workers interact with each other. Workers of the same team will be able to communicate remotely, sharing all kind of information and data, and connecting in real-time with their colleagues and their tools. Online communication will not substitute in-situ presence but rather complement it, thus improving the collaboration within working teams. It will also be easier for different teams to communicate with each other. This is of particular importance in steelmaking, as one of the core issues identified during the interviews was the poor alignment between different departments. Increasing teamwork and horizontal communication across the value chain of steel products is a challenge that companies are currently facing. It will grow in importance as the supply side will be required to provide more customised products. To support this argument, the input provided by several interviewees involved in this study suggests that the increased focus on product innovation and customer relations will require cross-functional teams.

The changes highlighted in Tier 3 will substantially influence Tier 2, i.e. the tasks that steelworkers will be required to perform in their daily work. More and more monotonous tasks will be absorbed by assistant systems and machines, while operators can perform more qualified work, and most importantly, make decisions based on the integrated data that machines will provide. Teamwork will become increasingly important, not only between co-workers, but also between workers and assistant systems.

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[190] FastCompany, "How AI is Changing the Way Companies are Organized", 28.02.2017, See: https://www.fastcompany.com/3068492/how-ai-is-changing-the-way-companies-are-organized, Last visited on 05.06.2019

[191] Gehrke, L. et al., A Discussion of Qualifications and Skills in the Factory of the Future: A German and American Perspective, 2015, p. 11

Overall, the profiles that are sought by the industry are not expected to be replaced altogether, but they will be expected to perform more tasks with a much broader scope. As one interviewee from World Steel pointed out:

> *"(…) workers need to have a wider knowledge and need to be able to do more because there are less and less specialised single jobs. Instead, the industry tends to need people who are able to work in multiple parts of the plant and on multiple operations throughout the career"*[192].

Continuous learning and flexibility will acquire even more relevance, as workers will be required to learn how to perform new tasks on-the-job through direct exposure to new processes and tools. The variety of tasks will also affect the composition of working teams, which will integrate profiles with different backgrounds and experience.

Arriving at the top of the pyramid, it is now possible to interpret the data collected on the expected evolution of skills needs with a much clearer view of the context in which they are analysed.

A first descriptive layer is provided by the survey for industry professionals. As Figure 13 shows, respondents were asked to select up to three skills from a list that they thought would be the most relevant in the next five years. Based on a total sample of 197 respondents, the database consists of 590 responses[193].

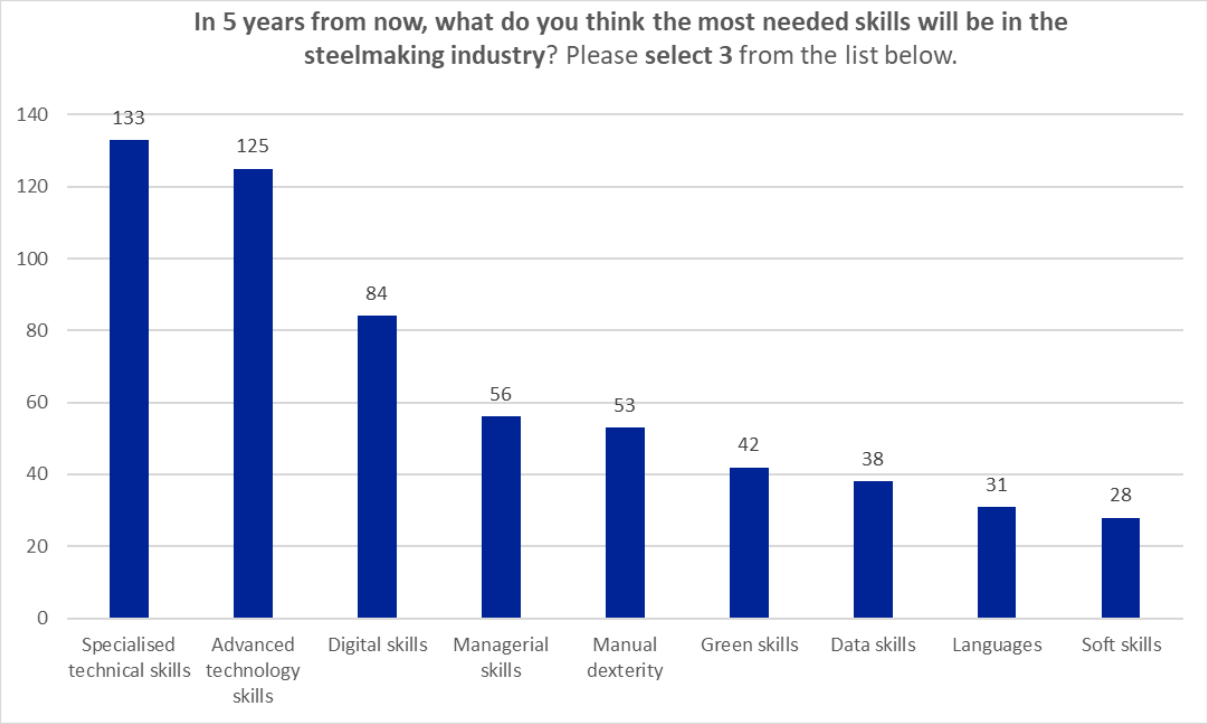

Figure 13 — Survey results - Survey for industry professionals: Perceptions regarding the most needed skills in steelmaking five years from now

Compared to Figure 7, which provided an overview of current skills needs, there is little variation with regard to the skills perceived as the most important for the industry in five years. Specialised technical skills and advanced technology skills remain high in the ranking. This result is in line with what emerges from literature review and interviews with expert stakeholders. Overall, the skills that were highlighted as key in Chapter 4.3.1, especially a specialised knowledge of steelmaking processes and materials, are not

[192] Interview notes - Education Providers, Representative from steeluniversity
[193] One answer was not considered in this overview because it was marked as "Other" and the clarification was "More qualified workers"

expected to be replaced, but rather complemented by the competencies related to Industry 4.0. Interestingly, less importance is given to manual dexterity, while the relevance attributed to digital skills rises substantially. A possible interpretation is that steelworkers will still be required to have an in-depth knowledge of specific tasks but will not be performing them. Machines and assisting robots will take on more and more manual tasks, whereas operators will be required to control them and intervene to ensure the smooth running of the production process. Technicians and operators will need to have sufficient digital skills to interact independently with automated plant facilities, understand data and devise actions and decisions out of the information provided by CPSs. The engineering profiles leading working teams will be expected to have an advanced understanding of the technologies applied to the factory processes and machines, with a strong focus on topics such as additive manufacturing and 3D modelling, data analytics and programming.

It is worth noting that the importance of managerial skills increases significantly on a five-year forecast. Skills like critical thinking, problem-solving and decision-making are perceived as crucial, which reflects the new roles that steelworkers will take on in the flat organisational structure of collaborative and team-oriented industrial environments. These will be equally relevant to technicians and engineers in leadership positions. The former will be progressively relieved from mechanical tasks and will see an increase in the quantity and complexity of the decisions they will have to take. The latter will act as the point of reference of working teams and will need to step out of a purely technical role and integrate decision-making and people management skills within their skillset. The analysis of job ads confirms this trend, as nearly all engineering positions reviewed were required to undertake people management tasks. For senior engineering positions, previous experience in operational leading teams was a recurring requirement, while more junior positions were often required to have people skills. Abilities such as critical thinking and independent problem solving were deemed important in several reviewed technical positions such as steel fabricators, welders, production operators and control technicians.

Data skills (i.e. the ability to monitor, understand and assess data) rank quite low among the priorities of survey respondents, with no substantial changes with regards to current and future skills. However, the changes brought by Industry 4.0 will require workers across the whole production area to not only interact with digital interfaces, but also to understand, elaborate and assess the large amount of data provided by these interfaces and use them to make informed decisions. As an example, high value-added solutions such as predictive maintenance and product quality prediction cannot be achieved without the operators' ability to identify potential problems at the right time.

Last but not least, while language proficiency and soft skills are expected to occupy the same space as they do now, green skills are projected to become increasingly important over the next five years. This can be explained by the efforts that the industry is making to meet the EU's 2050 environmental targets. Despite harsh global competition, the European steel industry remains a world leader with regard to the production of high-quality sustainable steel. Through the different funding lines set in place by the European Commission, European steel producers are researching new SCU and CDA processes to decrease the amount of CO_2 emissions (for further details, see Chapter 4.1). Furthermore, the end-of-waste criteria for iron and steel scrap adopted by the Commission contributed to incentivise the use of scrap steel in primary steel production. As reminded by EUROFER, steel remains at the core of different circular economy and industrial symbiosis processes due to its versatility.

As a consequence of the increased focus on sustainable steelmaking, environmental awareness and green skills are increasing in demand among European companies. A growing number of R&D profiles will be needed to lead cutting-edge research on new industrial processes, while it appears to be more common for companies to expect shop floor workers to have competences in resource efficiency, material reutilisation and recycling. As one expert interviewee pointed out, the market share of EAF, which is currently about 40% of the total market, is increasing. EAF produce on average a third less CO_2 compared to BOF (Basic Oxygen Furnace) and require only 20% of the workers needed

to operate a BOF. Mitigating job losses in the transition from BOF to EAF requires substantial reskilling of the workforce.[194]

A first response to the skills needed in the areas of environment was provided by the GT-VET project, carried out by a partnership of steel companies and research institutes under the Leonardo da Vinci Lifelong Learning Programme. GT-VET developed an industry-driven sustainable training module for industrial, mechanical, electrical and electronic technicians, which was integrated into the national VET systems of four European countries (Germany, Italy, Poland, and the UK). The module was designed to be adaptable to other technical professions and production industries and a first transfer was done in the automotive value chain with the GREEN STAR project[195]. Green skills are considered key to maintain the competitive edge of the European manufacturing industry and initiatives such as GT-VET have a high potential for replication.

In summary, Industry 4.0 and sustainability appear to be the main drivers leading the evolution of skills needed in the European steel industry. The transition towards Industry 4.0 will require workers to develop a solid understanding of complex organisational and technological processes as well as interact with digital interfaces and analyse larger amounts of data in their day-to-day decisions. Awareness of data security and protection will acquire importance as will trust in new technologies. Flexibility and transferability will become key, as nearly all steel shop workers will move away from monotonous and repetitive jobs and incorporate more varied tasks. As a result, personal skills like teamwork, problem-solving and decision-making will increase in importance, together with an aptitude for continuous improvement and lifelong learning. The focus of the European industry on low-carbon competitive steelmaking will create a stronger demand for research engineers (to reinforce companies' R&D departments), as well as technicians with competencies in material recycling and resource optimisation.

With regard to professional profiles, the majority of interviewees involved in this study agreed that the changes brought about by new trends will affect the skills required across already existing positions rather than cause the emergence of entirely new profiles. The only exception to that is administrative functions, which are expected to be fully incorporated by machines or by management-level positions. Nevertheless, the demand for skilled engineering professionals highlighted in Chapter 4.3.2 will increase and interviewees tended to point to an increase in demand for automation engineers and application managers, with a specific focus on data managers and data governance specialists. Although this study has not adopted an occupation-specific approach, the different research methods used during the research allowed the study team to create a high-level overview of professions that are currently in demand and are likely to stay so in the future (see Table 15).

Table 15 — Overview of in-demand profiles in the sector

In-demand profiles in the steelmaking industry	
Metallurgical engineers	Data governance specialists
R&D engineers	Data analysts
Application engineers	Application managers
Energy engineers	Quality technicians
Maintenance engineers and technicians	Welders
Automation engineers	Structural steel technicians
Process engineers	Process operators

[194] Interview notes - Workers' Organisation, Senior representative at Community (UK metalworkers' trade union)
[195] See: https://www.estep.eu/assets/GT-VET/Greening-technical-vocational-education-training-Flyer-english.pdf, Last visited on 14.06.2019

In-demand profiles in the steelmaking industry	
Design engineers	Furnace and mill operators
Production managers	Metallurgists
IT developers	Machinists
Electricians	Mechanics

4.4. Measures for up-/reskilling employees in the steel industry

The industry faces skills gaps and mismatches due to the changes that fall under the label of Industry 4.0 as well as the ageing of the workforce combined with the sector's image problem. This makes finding and retaining new employees difficult. Strategies and initiatives to reskill and upskill employees are needed to ensure that the industry stays competitive. On the policy level, however, the focus seems to be cross-sectoral rather than steel-specific. Policies do not address the steel industry and the skills specific to the industry, but rather take an encompassing approach that aims to tackle multiple industrial sectors.

> *"It's very hard to imagine a policy in place that is specifically aimed at the steel sector. Policy decisions can have an influence on different sectors at the same time. The answer to the needs of the steel sector does not come from policy, it comes from research. There are professors running steel-specific research groups, such as the ones teaching in the CASR[196]"[197]*

Public authorities sometimes collaborate with civil society and the private sector to translate national strategies into initiatives that foster upskilling and reskilling of the workforce. However, these public-private initiatives often target various industrial sectors at once. This means that, although they help address general skills gaps, they do not necessarily meet the specific requirements of the steel industry. This is also true for programmes provided at vocational schools and universities. Industry-specific degrees are becoming increasingly rare with the focus switching to educating T-shaped individuals who have a broader skillset and are able to move across different sectors and different functions. Some exceptions are constituted by programmes that are organised in cooperation with private companies for the purpose of creating a pool of suitable candidates to fill future vacancies. For instance, the Silesian University of Technology in Poland organises metallurgy courses with the full support of the steel producer PGO, and the University of Perugia in Italy offers steel-specific classes for Industrial Engineering students in collaboration with Acciai Speciali Terni (AST). Arginta Engineering in Lithuania even acquired part of the Vilnius Jeruzale Labour Market Training Centre to ensure that the VET school keeps providing the needed workforce.

Due to the wider scope of policies and education, the majority of the measures that are implemented to upskill and reskill employees in the steel sector and enable them to tackle new tasks is often privately financed and implemented by individual companies. According to World Steel, steel companies provided workers with an average of 7 training days in 2016 and 6.1 training days in 2017[198]. It should be noted that bigger companies like Sidenor, Tata Steel Europe, thyssenkrupp and Voestalpine tend to be better placed to

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[196] Centre for Advanced Steels Research, University of Oulu. The Centre consists of eight research groups from three faculties, notably: materials and mechanical engineering; process metallurgy; nano and molecular systems; biomimetics and intelligent systems; environmental and chemical engineering; future manufacturing technologies; industrial engineering and management https://www.oulu.fi/casr/. Last visited on 31.05.2019.

[197] Interview notes - Industry Stakeholders, Senior representative of the Association of Finnish Steel and Metal Producers

[198] World Steel Association, Sustainable steel. Indicators 2018 and industry initiatives, 2018, p. 8, See: https://www.worldsteel.org/media-centre/press-releases/2018/Sustainable-steel---indicators-2018-and-industry-initiatives.html. Last visited on 02.06.2019

launch initiatives, set up a system of internal qualifications and offer in-house training schemes and apprenticeship programmes. For instance, Voestalpine invested EUR 54 million in training in the business year 2017/2018[199]. 75.6% of employees participated in training and continuing education measures and over 791,500 hours of training were supplied at company level. In 2017-2018, thyssenkrupp had 3,162 apprentices in 62 different occupations. Since December 2017, it has an agreement with IG Metall, the main union of metalworkers in Germany, to support integrated degree courses[200].

Company-led initiatives entail educational programmes suitable to various levels of seniority (e.g. dual learning, short training classes, seminars, in-house academies) and professional experiences for entry level employees, university students or even pupils (e.g. summer jobs, apprenticeships, field research for Master students). The major steelmaking companies often rely on internal initiatives, which are designed to fit specific job profiles. Whilst these initiatives can be effective in responding to an urgent need of the company, they may not last long or respond adequately to future needs. "[Companies] launch initiatives that are just an impulse, but do not build a long-term success story"[201]. Even if several cooperation measures exist between companies, universities, technical schools and public bodies, companies lack long-term, forward looking competence strategies. Moreover, "it is very hard to engage the workforce in training and up-/reskilling programmes if the company fails to convey a shared vision of where it wants to go with its employees"[202]. The standardisation of such initiatives and training schemes across companies, based on the development of a clearer competence strategy, would make them more sustainable in the long term, optimising the costs of training for the individual companies, while also allowing employees to have greater flexibility in their career development.

The elaboration of a clear competence strategy is possible if companies utilise effective skills anticipation tools to predict skills needs. With a few exceptions (e.g. Finland, where "analyses of future skills needs are highly institutionalised at the national level […]; there are foresight bodies both in the Parliament and in the Government"[203]), data suggests that most companies at the moment do not have a systematic process for assessing skills needs and predicting future needs in place, but still provide training classes.

Although many survey and interview respondents from the steel industry declared awareness of the impact of new industrial and technological trends on steelmaking, relatively few of them declared that their company had a structured foresight strategy to anticipate these trends and understand what skills will be the most needed to meet future challenges (see Chapter 4.3.2). Among the few respondents who did answer positively when asked if their company had any method to anticipate skills needs, the most used methods appear to revolve around direct contact with personnel and experts and cooperation and networking with foreign counterparts and suppliers. Other methods include: annual diagnoses of vacancies, redundancies and training needs, annual evaluation of employees with competence assessments, and interpretation of statistical data.

This was further confirmed by several experts from industry and academia, as well as trade union representatives. According to them, the majority of steelmaking companies, especially the smaller ones, still lack the adequate tools to predict how macro-economic changes will affect them specifically and are unable to devise concrete actions to address these changes. Some exceptions can be found with major steel producers. An example is provided by the Advanced Analytics Academy created by Tata Steel Europe in Ijmuiden,

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[199] Voestalpine, Corporate responsibility report 2018, 2018, p.94
[200] ThyssenKrupp, Annual Report 2017/2018, 2018, p.92
[201] Interview notes - Education Providers, Representative of a Dutch university
[202] Interview notes - Education Providers, Senior scientist at the advanced steel research centre of a British university
[203] Berge, T., Berg, L., , Analysis, dialogue and dissemination of future skills needs - A study of three countries, VOX, Norwegian Agency for Lifelong Learning, 2015

which provides training in data analytics to a number of roles, including data scientists and data engineers, but also workers needing a sound understanding of data analytics (e.g. managers and digital translators)[204].

Formal initiatives represent only one side of the coin. Informal education also plays a fundamental role in industries that still require manual dexterity and a feeling for the functioning of the machine. "There are skills that cannot be taught in classes. Since not everything is automated yet, there is still a need to understand the machinery and to feel it, as it were. This is something only experienced people can teach"[205]. This is especially important in the steel sector because of the transition period it is facing, with a large part of the experienced staff being expected to retire. More generally, on-the-job learning is crucial for staff members transferring between sections and also to train candidates with previous experience in other sectors who may join the steel industry later in life. It should be noted that lower skilled workers tend to be more subject to informal education practices, while higher skilled workers are more likely to have access to formal training (as suggested above).

As detailed in Chapter 4.3.2, there is little evidence of systematic processes to facilitate knowledge transfer, although some companies are trying to set up internal wikis where material can be stored. Due to the complexity of systematising practical know-how, mentoring and coaching are two methods that are commonly adopted by companies to prompt on-the-job learning efficiently.

> *"It is crucial to increase exchanges between older and younger steelworkers to preserve past skills and knowledge because lots of workers will leave their position in the next future due to ageing; on the other hand, it is also important to teach senior steelworkers how they can benefit from new technologies and how they can use them to improve the industry"[206].*

Informal upskilling and reskilling actions are hard to track because they are not recorded and assessed in a systematic way and little information is available to externals. Therefore, the following sub-chapters of this report focus on formal measures in the policy sector, for education and at company level.

4.4.1. The role of policymaking

The interviews and the survey indicate that policies do not address the skills needs of the steel sector specifically, but rather consider skills gaps at a more general level, looking especially into the promotion of STEM and digital skills. "There is not a steel-specific agenda. However, there is a smart industry agenda. This is meant to promote technical industries, including steel"[207]. Participants in the study also acknowledged that cooperation between the steel industry and policy makers could be strengthened, fostering greater connections especially about skills development strategies. For example, although the British Government established the Steel Council in 2015 and the Steel Council advocated to develop a sectoral skills strategy, employers did not engage in the initiative[208]. In most cases, companies collaborate with universities and trade organisations and they less frequently engage with government representatives.

Furthermore, industry stakeholders may be unaware of the efforts made in this direction by the EU and claim that the steel sector is rarely the object of national policies. Nonetheless, they do not underestimate the impact that policies in other sectors, such as

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[204] World Economic Forum, Fourth Industrial Revolution - Beacons of Technology and Innovation in Manufacturing, 2019, pp. 34-35
[205] Interview notes - Industry Stakeholders, Representative of a Sweden-based international steel manufacturing company
[206] Interview notes - Education Providers, researcher at Sant'Anna university
[207] Interview notes - Public Authorities, Official from a Dutch regional authority. See https://www.techniekpact.nl/nationaal-techniekpact-2020, Last visited on 14.06.2019
[208] Interview notes - Workers' Organisation, Senior representative at Community (UK metalworkers' trade union)

energy and environment, can have on the steel sector. Energy efficiency and decarbonisation standards are requiring companies to set up research programmes to innovate production processes and products to maintain compliance. The Commission's new industrial strategy[209], with its sectoral and cross-sectoral actions (e.g. EU Strategy on Clean Steel, European Pact for Skills, Industrial Forum, etc.), may lead to closer cooperation between the steel industry and policymaking.

Migration policies and integration measures also play an important role in countries with high immigration rates such as Germany and can contribute to informing or counteracting patterns of discrimination (e.g. following the large scale inward migration of people from Turkey to work in the German steel industry, Turkish workers tended to fill low-skilled occupations and be at greater risk). In recent years, industries have been involved in initiatives contributing to the integration of refugees. For this purpose, they can provide introductory training and apprenticeship places to subsequently employ successfully skilled refugees. thyssenkrupp is exemplary in this, having taken part in "We Together" (as described in Chapter 4.2.3).

A policy area whose relevance is growing for heavy industries like steel is equal opportunities and gender equality. The steel sector is required to create an environment that is suitable for women to work, but also to provide training that gives women access to leadership positions. This can be convenient for the industry itself, which could mitigate the effects of the workforce crisis by accessing one of the largest and most underused pools of talents.

More generally, policies in the education area can have a strong impact on how companies in manufacturing industries approach lifelong learning and employees' training. Ensuring that each worker has the right to receive training or to pursue lifelong learning would contribute to filling the skills gaps. This will help companies devise clearer and more thorough competence strategies. Policies in the education field can also help strengthen the provision of VET courses and dual education systems, which seem to be a best practice in places like Finland, Germany or Sweden, but appear not to be sufficiently developed in countries such as Italy or Spain. It should be noted that a position paper published in February 2019 by six European networks of education providers (i.e. EVBB, EfVET, EUproVET, EVTA, EURASHE and EUCEN) to discuss the EU's policy for VET provision after 2020 welcomes the "… integration of general and vocational education from an early age. This will not only erase the distinction between vocational, general and professional education but also help students to develop more perceptions and attitudes that are more realistically aligned with the future of work"[210]. Moreover, "[d]ue to the speed of change and the long period of participating in working life a stronger focus should be on lifelong learning opportunities"[211].

Overall, it appears that industry stakeholders and education providers in the steel sector consider a higher degree of cooperation with public authorities helpful to create a supportive framework for the industry. However, they also believe that specific work can only be done at local level, and policies have to be accompanied by regional implementation plans that strongly engage local companies.

The table below provides an overview of some of the national policies, strategies and measures (ongoing or recently implemented) led by public bodies that have had an impact on the upskilling and reskilling of the workforce in the steel sector.

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[209] European Commission, "A new industrial strategy for Europe", COM(2020) 102 final, European Commission, Brussels, 10.03.2020

[210] VET4EU2, *Position paper on the European Union policy after 2020 on Vocational and Educational Training by the European VET providers associations cooperating in VET4EU2*, 2019, p.7

[211] Ibid., p.8

Table 16 — National policies to upskill and reskill employees

Name	Description	Organisation involved	Country
Pospolu/Together	Pospolu is the acronym of the project 'Fostering Cooperation between Schools and Entreprisis'. Co-financed by the European Social Fund (ESF), it ran from December 2012 to October 2015 to promote an effective and easier cooperation between schools and companies and to elaborate a cooperative model for VET including some dual system elements and elements of the European Credit System for VET (ECVET). Among other activities, schools could also take part in the development of methodological and educational materials, thus innovating teaching in the corporate environment. At the same time, employers could secure practical training at their premises[212].	Ministry of education youth and sports, National institute for education and training Prague, employers' associations	CZ
Valtakunnallinen ammatillisten osaamistarpeiden ennakointiprojekti – VOSE (National Vocational Skills Foresight Project)	The project, co-funded by the ESF, involved a multi-stakeholder network in the development of an operational foresight model that includes processes, methods and systems to anticipate professional skills needs at national level, and thus, better coordinate education and training efforts. Quantitative foresight was regarded as an essential tool to tackle the generational change, ensure the competitiveness of Finland, and foster the country's innovation capacity[213].	National Board of Education	FI
Foresight.fi	The National Foresight Network (NFN) website was created to conduct regular foresight work and raise awareness about challenges and opportunities, so that they can be discussed. As of January 2015, the NFN is supported by a Foresight Steering Group, appointed by the Prime Minister. Additionally, since 2015 an annual national foresight forum, FinnSight is organised jointly by the Academy of Finland, the Finnish National Board of Education (FNBE), the Ministry of Education, Science and Culture, the Finnish Innovation Fund Sitra, the Finnish Funding Agency for Innovation Tekes, the Ministry of Employment and the Economy, and the Prime Minister's Office[214]. These actions have been informed by the 2013 report "Cooperative and continuous foresight. A proposal for a national foresight approach"[215].	Office of the Prime Minister and the Finnish Innovation Fund (Sitra)	FI
Finland's Minerals Strategy	The Finnish Mineral Strategy aimed to develop training programmes addressing some priority areas to better combine environmental and mining technologies skills with skills in metal	Ministry of Employment and the Economy, Geological Survey	FI

[212] See http://www.nuv.cz/pospolu, last visited on: 21.06.2019
[213] Leveälahti, S., Järvinen, J. & Vesterinen, N., Selvitys ammatillisten osaamistarpeiden ennakointimalleista, Helsinki: Foredata Oy, 2009
[214] See http://foresight.fi/info-in-english/, last visited on: 21/06/2019
[215] Prime Minister's Office, Cooperative and continuous foresight - A proposal for a national foresight approach, Prime Minister's Office Reports 2/2014, Prime Minister's Office, 2014

Name	Description	Organisation involved	Country
	processing, machinery and equipment manufacturing. The priority areas were "invisible and intelligent mining; innovative processes, automation and optimisation; efficient use of materials, energy and water; minimisation of emissions; chemical/biological beneficiation processes; geodata systems and multi-dimension modelling; innovation exploration technologies; high-tech metal exploration and beneficiation; recycling new and alternative materials; environmental impact management and measurement" [216]. The strategy also enhanced the importance of ensuring that the mineral sector is considered during education provision to foster R&D and innovation in the long term.	of Finland, HMV Public Partner Oy	
National road map to a circular economy	First introduced in 2016, the national road map was updated in March 2019[217]. It contains actions that different stakeholders can take to accelerate the country's transition towards a carbon-neutral circular economy by 2025, including ways to achieve net-zero emissions from EU steel, plastics, ammonia and cement production while keeping that production in the EU[218].	Finnish Innovation Fund (Sitra)	FI
Industrie du Futur (Industry of the Future)	This programme was launched in April 2015 to support companies from different industrial sectors, including steel, in their transition towards Industry 4.0 (for instance, helping companies deploy digital technologies or modernise production practices) resorting to private and public funding. In 2017, the programme joined a trilateral cooperation with Germany (Plattform Industrie 4.0) and Italy (Piano Impresa 4.0).	French government	FR
VET reform	A reform of the French VET system was initiated in May 2018 to increase the engagement of social partners in the development of VET curricula, enhance the prestige of VET and expand apprenticeships to all vocational high schools[219]. By promoting an alternation between classroom-based learning and in-company training, the reform contributed to improving the match between skills supply and demand and students' transition to work.	Ministry of Education	FR
Plattform Industrie 4.0	The Industrial Platform 4.0 is Germany's central alliance to coordinate the structural shift towards a digital, smart industry. It brings together over 300 participants from	Federal Ministry for Economic Affairs and Energy	DE

[216] Geological Survey of Finland, Finland's Minerals Strategy, 2013, p.16
[217] See https://www.sitra.fi/en/projects/critical-move-finnish-road-map-circular-economy-2-0/, last visited on: 21/06/2019
[218] See https://www.sitra.fi/en/publications/industrial-transformation-2050-pathways-to-net-zero-emissions-from-eu-heavy-industry/, last visited on: 21/06/2019
[219] See: http://www.cedefop.europa.eu/en/news-and-press/news/france-new-vet-reform-launched

Name	Description	Organisation involved	Country
	over 150 organisations and offers concrete solutions and practical examples to support companies of various size in their transition towards the Industry 4.0. Since 2017, the platform is part of a trilateral cooperation with France (Alliance Industrie du Futur) and Italy (Piano Impresa 4.0).		
National Plan Industry 4.0	The Italian national plan for Industry 4.0 (also known as 'Piano Calenda') has been developed to foster concrete actions supporting the digitalisation of the manufacturing industry. Since 2017, the National Plan has been strengthened by means of a trilateral cooperation with France and Germany, as indicated above.	Ministry of Economic Development	IT
Alternanza scuola-lavoro (school-work alternation)	The regulation about school-work alternation was launched in recent years to give students the chance to spend time working in a company in the frame of a specifically tailored internship, while still studying, to strengthen the relationship between schools and industry, and increase the competitiveness of students when approaching the job market[220].	Ministry of Education, Universities and Research	IT
Techniekpact (Technology Pact)[221]	The national strategy was launched in 2013 and renewed in 2018 to improve the connection between education and technical positions and contribute to addressing the lack of technical profiles on the market.[222] The new Techniekpact aims to promote technical and technological skills and knowledge and their application to non-technical fields, including healthcare, nutrition, energy and sports. The strategy entails 12 overarching goals and regional pacts and actions to facilitate implementation.	60 different organisations from industries (among them, Tata Steel Europe), academia and public authorities	NL
Youth and Technology Network of the Netherlands	A network of education providers, government representatives, industry representatives and other partners of the Techniekpakt was created to achieve Goal 7 of the Techniekpact (i.e. "Education and business work together to train vocational education teachers"[223]) by means of knowledge sharing and the development of relevant and valuable teaching material and curricula in different sectors. As far as the steel sector is concerned, Tata Steel Europe is involved in strengthening the cooperation between educational providers and the industry, and	Tata Steel Europe (for the steel sector)	NL

[220] See: http://www.alternanza.miur.gov.it/normativa.html, Last visited on 15.05.2019
[221] See https://www.techniekpact.nl/nationaal-techniekpact-2020, last visited on: 11.06.2019
[222] Updated information for 2019 and the related infographics are available on the Techniekpact Monitor (https://www.techniekpactmonitor.nl/, last visited on: 11/06/2019). The overview of the implementation progress is provided in the report 'Rapportage Nationaal Techniekpact 2020. De tussenstand in 2019', 20 May 2019.
[223] See https://www.techniekpact.nl/cases/vohonetwerk-amsterdam-tata-steel-verzorgt-opleidingen-docenten-beroepsonderwijs, last visited on: 21/06/2019.

Name	Description	Organisation involved	Country
	participates in the development of curricula that are in line with the needs of the sector.		
Focus op Vakmanschap 2011-15 (Focus on Craftmanship action plan 2011-2015)	The action plan for upper secondary vocational education (MBO) was launched to increase the professionalisation of staff through skills-based education, career guidance, knowledge transfer and professional development (e.g. leadership training for middle management). The plan also aimed to simplify the educational system and the qualification framework, while improving the quality of education and strengthening career guidance[224].	Ministry for Education, Culture and Science	NL
Samenwerkings organisatie Beroepsonderwijs Bedrijfsleven – SBB	The Foundation for Cooperation on Vocational Education, Training and Labour Market was set up in 2012 to strengthen the alignment of study curricula with the needs of the industry. Being composed of stakeholders from the industry, education providers and social partners, SBB acts as the link between VET institutions and industries. It identifies companies offering internships and work placements and supervises the qualifications provided by VET institutions in different sectors.	Ministry for Education, Culture and Science, MKB Nederland, VNO-NCW, FNV, CNV, LTO Nederland, VCP, MBO Raad, AOB, NRTO	NL
Future Industry Platform	This national programme was launched in 2018 to provide funding over a 25-year period in support of the digitalisation of the industry as part of Poland's Responsible Development Plan (the 'Morawiecki Plan')[225]. Education and training are considered an important part of the programme. Furthermore, a network of Industry 4.0 competence centres is to be established. The platform brings together all who are interested in Industry 4.0 and aims to accelerate the digital transformation of the Polish industry with the reskilling of the workforce.	Ministry of Finance and Development	PL
Skills Development Programme	Launched in 2014 and funded under POWER (Knowledge, Education and Development Operational Programme), the programme included measures to strengthen entrepreneurship, interpersonal and analytical skills, and specific professional competencies. It focused on workshops, use of ICTs in HE, and promoting modular education and interdisciplinarity. It complements the activities targeting skills of existing employees, which are limited to the Registry	Ministry of Science and Higher Education	PL

[224] Cedefop, Vocational education and training in the Netherlands: Short description, Luxembourg: Publications Office of the European Union, 2016

[225] European Commission, Digital Transformation Monitor, Poland: "Initiative for the Polish Industry 4.0 - The Future Industry Platform, 2018

Name	Description	Organisation involved	Country
	of Developmental Services and the National Training Fund[226].		
Strategy for the Development of Human Capital 2020 (2013) and Lifelong Learning Perspective (2011)	After the modernisation of the national qualifications framework and the strengthening of links between the VET system and employers, two general strategies were launched aiming to support the uptake of relevant competences by people and increase the connection between education provision and the labour market.	Ministry of Science and Higher Education	PL
VET reforms (2015)	Reforms in the education field financed via the state budget and EU Structural Funds to promote the excellence of VET as an educational system, financially support companies in the provision of vocational programmes for youth, and foster the collaboration between the industry and the Ministry of Education to better align skills demand with supply.	Ministry of Science and Higher Education	PL
Bilans Kapitału Ludzkiego – BKL (Human Capital in Poland)	This research project was conducted between 2009 and 2015 and repeated between 2016 and 2023 to gather data on the scale and causes of skills gaps and competency mismatches. The key aim is to provide evidence to inform policymaking for education and the labour market so that the skills gaps can be bridged and employers' skills needs are satisfied by the workforce.[227]	Polish Agency for Enterprise Development (PARP), Centre for Evaluation and Analysis of Public Policies at the Jagiellonian University (CEAPP)	PL
Modernisation of vocational training centres in Lower Silesia	ERDF-funded project in Lower Silesia (2009-2015) aiming to facilitate the alignment of vocational education with the needs of the regional labour market and provide graduates of vocational schools with the right competences for key industries for the region. The project also led to the setup of educational centres equipped with modern technologies and tools. 415 vocational training rooms were equipped, with over 20,000 pieces of modern technological equipment purchased (e.g. numeric machine tools with full software). This new equipped didactic base serves about 25,000 young people[228].	Lower Silesia Marshal Office	PL
Alianza para la FP Dual (Alliance for dual VET)	The Alliance is a state-supervised network of companies, centres and institutions, committed to developing dual VET in Spain by improving the legal framework of dual VET and the image and prestige of VET in general. It was started in 2016 by five institutions and	Bertelsmann Foundation, the Princess of Girona Foundation, important business organisations like	ES

[226] See https://skillspanorama.cedefop.europa.eu/en/analytical_highlights/poland-mismatch-priority-occupations, last visited on: 21/06/2019
[227] Sienkiewicz, Ł., Mutual Learning Programme. Host country discussion paper – Poland: "Study of human capital in Poland: From research project to backbone of labour market intelligence in Poland", European Union, Directorate-General for Employment, Social Affairs and Inclusion, 2016
[228] See https://ec.europa.eu/regional_policy/en/projects/poland/vocational-training-for-25-000-students-in-lower-silesia, Last visited on: 21.06.2019

Name	Description	Organisation involved	Country
	already has more than 650 members, many of which are companies.	CEOE-CEPYME, the Spanish Confederation of Employers' Organizations, and the Chamber of Commerce of Spain	
Collective Agreement of the industry, technology and services of the metal sector	In 2017, with the Resolution of 7 June 2017 of the Directorate General of Employment, the second Collective Agreement of the industry, technology and services of the metal sector was registered and published. The signatories commit to work towards the upskilling and reskilling of the workers and entrepreneurs in the metal sector, define specific qualifications and professional competences needed for the sector, and identify suitable training and education provision to facilitate professional insertion.	Ministry of Labour, Migrations and Social Security	ES
I came, I saw, I stayed – Action for future competence recruitment in the metals producing industry	Funded by the Swedish government innovation agency Vinnova (SEK 4,000,000) under the innovation partnership programme "A connected industry and new materials", the project aims to test and evaluate ideas to strengthen competences, promote cross-learning and contribute to improve the industry's ability to attract and retain future employees.[229]	Jernkontoret, Vinnova	SE
National Action for Metallic Materials	"National Action for Metallic Materials" is a strategy document for the innovation in the metallic materials area. The agenda includes visionary concepts, goals and strategies. These concern how growth can be energised in Sweden and industry's competitiveness strengthened while meeting societal challenges with a global dimension.[230]	Jernkontoret, Svenskt Aluminium and the Swedish Foundry Association	SE
Metallic Materials	This strategic innovation programme brings together Sweden's metal producing industries encompassing steel, aluminium, hard metal, steel castings, cast iron and non-ferrous metal castings. The programme aims to make the sectors more innovative by stimulating collaboration between the industry, the public sector and academia[231]	Jernkontoret, Vinnova, Swedish Energy Agency, Research Council Formas, Svenskt Aluminium, Swedish Foundry Association, Faculty of Engineering at Lund University	SE

[229] See https://www.vinnova.se/en/p/i-came-i-saw-i-stayed--action-for-future-competence-recruitment-in-the-metals-producing-industry/, last visited on 20/06/2019

[230] The Swedish metals-producing Industry's associations: The Swedish Steel Producers' Association (Jernkontoret), Swedish Aluminium, Swedish Foundry Association, National action for metallic materials – A strategic research and innovation agenda, 2013

[231] See https://www.jernkontoret.se/en/research--education/metallic-materials/, Last visited on 20.06.2019

The table below provides a short overview of the European policy framework and policy initiatives focusing specifically on skills development.

Table 17 — European policy framework and policy initiatives for skills development

Name	Description	Organisation involved	Country
Action Plan for Steel	Dating back to 2013, the Action Plan for Steel listed the trends in steelmaking technology and steel use, which influence the demand for steel, requiring for instance, different processes, innovative steel products and new skills. The Plan identified areas where the EU may become a leader, provided its workforce has suitable skills.	European Commission	EU-wide
Steel: Preserving sustainable jobs and growth in Europe	The Communication "Steel: Preserving sustainable jobs and growth in Europe" (COM(2016) 155 final, European Commission, Brussels, 16.03.2016) announced measures with which the Commission aimed to help the steel sector remain competitive and innovate, leveraging quality, modern technology, efficiency and skilled workforce. The Commission pursued the preservation of a level-playing field and the creation of a favourable business environment through successive efforts in the adoption of the trade defence modernisation proposal and of a prior surveillance system on steel products as well as various investment instruments for trade, innovation, competition, the Energy Union and reskilling/upskilling of steel workers. The Communication foresaw close cooperation with Member States and social partners.	European Commission	EU-wide
A new industrial strategy for Europe	The Communication "A new industrial strategy for Europe" (COM(2020) 102 final, European Commission, Brussels, 10.03.2020) announced measures that the Commission plans to adopt to promote a competitive, green and digital Europe, fostering innovation, sustainability and skilling/reskilling. These include, among others, a new "Pact for Skills" to unlock public and private investment in the workforce; an update of the Skills Agenda for Europe; new Public Private Partnerships to stimulate innovation under the Horizon Europe programme; the implementation of the EU Gender Strategy to encourage women to study STEM subjects; support towards the development of breakthrough technologies for zero-carbon steelmaking; and the setup of an Industrial Forum to discuss industrial needs.	European Commission	EU-wide
New Skills Agenda	This policy programme was adopted in 2016 to promote the development of the European workforce's skills in strategic economic sectors, leading to the launch of a number of strategies and measures aimed at improving sectoral skills in Europe. The New Skills Agenda encouraged the creation of 'Skills Alliances' that have helped define skills needs and design strategies to bridge gaps and	European Commission	EU-wide

Name	Description	Organisation involved	Country
	minimise mismatches in different sectors. Close cooperation between a multiplicity of stakeholders – e.g. SMEs, local and regional governments, trade unions, sectoral associations, education providers, entrepreneurs, employers, employees, potential employees, the general public – is encouraged to close skills gaps and improve skills provision and acquisition.		
Blueprints for Sectoral Cooperation on Skills	Two waves of Blueprints for Sectoral Cooperation on Skills were launched to support projects identifying and addressing skills gaps. The first wave included the following five sectors: automotive, maritime technology, space-geo information, textile clothing, leather and footwear, and tourism. The second wave included additive manufacturing, green technology and renewable energy, construction, maritime shipping, paper-based value chain and steel. The blueprints for the automotive sector, the construction sector and renewable energy are of particular interest for the steel industry, considering that the former are downstream users of the latter. Different projects emanated from the Blueprint, such as DRIVES (development and research on innovative vocational education skills), led by 24 European stakeholders.	European Commission, EASME	EU-wide
Working Group People	The Working Group People works to promote a modern education system that is in line with the requirements of the market, to offer workers lifelong learning opportunities and to support the application of new technologies and working practices to ensure safe working environments in the steel industry. Through its activities, the Group aims to "contribute to ensuring the supply of the highly skilled scientists, technologists, innovators and managers who will take the European steel industry forward and provide new sources of competitive advantage" [232].	ESTEP	EU-wide
Sectoral Social Dialogue Committee	Since 2006, the Sectoral Social Dialogue Committee is the main forum to discuss the challenges faced by steel companies and find possible solutions. Sectoral Social Dialogue Committee discusses various issues, including: the global competitiveness of the European steel industry, opportunities to boost employment in the EU steel industry, talent management, the ageing workforce, participation in HLG on energy intensive industries, climate change policy, industrial policy on raw materials and trade[233].	EUROFER, ESTEP and IndustriALL	EU-wide

[232] See https://www.estep.eu/estep-at-a-glance/working-groups/wg-people/, Last visited on 20.06.2019
[233] See http://ec.europa.eu/social/main.jsp?catId=480&langId=en&intPageId=1853, Last visited on 20.06.2019

4.4.2. The role of education

A common pattern across the EU is the widening scope of educational programmes, even in regions characterised by steel production. The city of Swansea, for instance, has a long-standing industry in steel and metalwork education thanks its proximity with Port Talbot, the town where Tata Steel is based. However, "education has changed, moving from an offer that was very much focused on the steel industry to a more general set of programmes that apply to different industries"[234]: "courses are now more generic, which means that you miss the details. They provide competences that can help serve the needs of engineering industries at large"[235]. The provision of education does not focus on the steel industry. Rather, it is meant to provide students with a broader skillset that can enable them to work in different sectors and change functions in their professional careers. A too-specialised offer is seen as unsustainable in the long run and steel-related degrees are progressively being eliminated or replaced by more general degrees as the number of students enrolling has decreased over the past years.

> *"Overall, graduates lack metallurgical knowledge … engineering programmes are not strong for steel-related subjects. Not much is being done at the moment to address this gap. Actually, there are less and less courses on this ... It is a vicious circle: since less students are enrolling; the management then tends to remove or limit this kind of degrees. For instance, at TECNUN they taught Material Engineering from 1966 to 2010 and then stopped because of the lack of students and decline in undergraduates' interest in the programme. Also PhD programmes face difficulties: there is a lack good candidates, differently from other subjects"[236].*

Furthermore, there are skills that require access to relevant equipment that needs to be acquired. This goes beyond the resources of educational institutions.

Stakeholders acknowledge the fact that the best way to address the needs of the industry is learning on-the-job at the company itself. Nonetheless, industry representatives from the steel sector have a stake in keeping close contacts with relevant faculties and vocational institutions. It is not rare that industry stakeholders are invited to give lectures at universities. In certain cases, steel producers cooperate with schools and universities to support the provision of relevant training (e.g. maintenance, process engineering), while also giving visibility to the industry. The collaboration between industry and academia may lead to the development of full courses, as it happened at Bochum University, where a curriculum for metallurgists was elaborated following the advice of thyssenkrupp concerning the actual needs of the steel industry. More often, the collaboration is limited to the provision of shorter, specialised classes or seminars focusing on one specific aspect.

> "*The idea is that if there is a new thing that has become important and was not included in previous curricula, these short seminars [for people who are working (the continuous learning vocational courses)] provide the opportunity to teach them the basic issues. These are not long trainings, just 2-day seminars with focus on 1 aspect, as they expect that the participants already have the basic knowledge. […] There are also more specific seminars, for instance, when nuclear plants were being built in Finland, there was a specific requirement for materials linked to nuclear plants. A seminar was therefore organised on this. Another example is for seminars regarding the effects of the cold on different materials and how to think about this issue*"[237]

Some companies also allow students to carry out a traineeship or work on their thesis (Master's or PhD's) in relation to one of the concrete problems that the company is facing. This is seen as an opportunity to get students acquainted with the steel sector, while also letting them acquire the skills that are most needed for the company. Therefore,

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[234] Interview notes - Education Providers, Professor at the Swansea University
[235] Interview notes - Education Providers, Professor at the Swansea University
[236] Interview notes - Education Providers, Associate professor at TECNUN (Universidad de Navarra)
[237] Interview notes - Education Providers, Professor at the University of Oulu

partnerships between universities and companies or research centres are acquiring a growing importance to support high-level research.

As the national reports illustrate in greater detail, there are considerable differences among countries, which also depend on the organisation of the education system as a whole. In countries like Sweden, pupils are required to decide early on what type of education they will follow. Some degrees, which are needed to work in the steel industry, do not allow students to then access HE and this may discourage young people from opting for such a career path. Other differences are related to the distinction between traditional and vocational education. Among European countries, Germany is considered particularly strong in the provision of dual education and students from VET programmes are considered to be more suited to meet the needs of the industry than VET students from countries like the UK. Last but not least, countries differ in their strategies concerning lifelong learning. For instance, France reorganised continuous education in 2018 with substantial effects on the whole labour market: "Every employee/worker has the right to continuous education (depending on the position and the profession, everyone is entitled to a certain number of hours of training every year) and has a "passport" of all the training and classes taken during the professional careers"[238].

Within the companies, upskilling and reskilling tends to be done in-house for specialised functions that are expected to recur in time, while it is outsourced for more general skills (e.g. project management, soft skills). "Specialist training of employees at the request of employers can be run by the Centre of Continuing Education (CKU)"[239]. Training, however, represents a considerable cost for enterprises and it is carried out if it is perceived as a long-term investment. Therefore, older workers tend to undergo less training and outsourcing remains a solution for very specific tasks that are not expected to become routine. Most companies have some mandatory training courses for all employees (for instance, on safety), which they combine with demand-driven and needs-driven courses. For instance, Franchini Acciai (Italy) organises a Steel Metallurgy course to make sure workers are aware of the main metallurgical concepts concerning steel forging and heat treatment as well as the criteria for steel selection and process optimisation.

To counter the lack of steel-specific educational programmes, international companies have developed in-house academies and universities (e.g. ArcelorMittal University), where students can learn the procedures of steelmaking, receive dual education, combining theory and practice in different units and becoming part of the company's pool of suitable candidates for direct employment. For example, Tata Steel Europe offers different types of traineeships (technical and business) and apprenticeships (in mechanical engineering, electrical engineering, logistics, process technology) to local students. The aim is to train them on specific techniques in the working place. The apprentices at the Ijmuiden plant get acquainted with the job in a dedicated Training Centre with simulation laboratories. Compagnia Siderurgica Italiana (Pittini Group) has designed "Steel Training" through its own Corporate Business School and in partnership with the Bearzi Institute. This 12-month work-based learning (WBL) course is for graduate students who are offered a permanent contract and the possibility to develop their skills within a dynamic company.

The development of educational programmes and training schemes can also be led by producer and manufacturer associations, as exemplified by the German Steel Institute VDEh or Riconversider in Italy. The former has its own academy to promote technical know-how and meets the needs of thyssenkrupp. The latter is a specific body created by the Italian association of steel producers (Federacciai) to help its members organise training courses and access public funding.

Teaching involves the use of mixed methods, ranging from traditional learning (face-to-face) to e-learning and gamified tools. "Gamification is used especially for younger generations in apprenticeships. In the future, the company could consider using wikis and

[238] Interview notes – Industry Stakeholders, CEO of a steel consultancy with long-term previous experience in ArcelorMittal and involvement in ESTEP

[239] Interview notes - Industry Stakeholders, Senior representative at the Instytut Metalurgii Żelaza im. St. Staszica in Poland

other platforms to foster the development of digital skills"[240]. With regard to gamification and e-learning practices, steeluniversity represents an important example. It uses an online version of a boardgame to help students develop business skills, which are perceived as growingly important in the US. Upskilling and reskilling in the European steel sector focuses more on vocational skills (needed to understand and perform operations at a steel plant) and European companies are more reluctant to take up a gamified approach. As the VET4EU2's position paper puts it, "Several methods (apprenticeship, WBL[241], job shadowing, experiential learning, peer to peer learning and digital tools like massive open online courses (MOOC's), flipped learning and virtual reality or serious gaming) must be used to reach the best results"[242].

It is note-worthy, however, that there are practices which cannot be taught in a formal setting and can only be learned through informal education. This makes knowledge transfer particularly problematic, especially for an industry where the number of older workers who retire is increasing and new employees are hard to find. Companies seem to have no systematic way to tackle this issue, besides mentorship and coaching. There are of course exceptions, such as the Senior Experts GmbH organisation founded by thyssenkrupp to build a pool of retired or soon-to-retire experts and executives. Ex-employees who have senior, experienced profiles can work as interim managers on specific projects.

> "*The senior experts provide decades of experience on demand. The program is directed at people from all areas and all levels of the company. This allows us to keep expertise in the company while raising the profile of older experts and supporting the success of entrepreneurial projects in accordance with the needs of our business*"[243].

The tables below provide some examples of specific initiatives that have been carried out by universities and companies with a specific focus on the steel sector.

Table 18 — University-led initiatives for skills development

Name	Description	Organisation involved	Country
METaL	The METaL project aims to address skills shortages in materials and manufacturing via WBL leading to a general upskilling of the workforce. This will ultimately help secure sustainability for the Welsh industry. The project is funded by the ESF[244].	Welsh Government, Swansea University	UK

[240] Interview notes - Industry Stakeholders, Leading representative at thyssenkrupp Europe Training Centre
[241] Work-Based Learning
[242] VET4EU2, *Position paper on the European Union policy after 2020 on Vocational and Educational Training by the European VET providers associations cooperating in VET4EU2*, 2019, p. 8
[243] thyssenkrupp, *Annual Report 2017/2018*, 2018, p. 95
[244] See: http://www.project-metal.co.uk/, Last visited on 14.06.2019

Name	Description	Organisation involved	Country
Joint programme in metallurgy	The Silesian University of Technology collaborates with the steel producer PGO in the framework of a programme dedicated to current steelworkers as well as job seekers who wish to develop their technical knowledge in metallurgy. During this one-year course, participants are trained through a combination of theory and practice. The practical part is carried out at the PGO facilities. The objectives of the programme are: to increase the motivation and self-development opportunities for current workers, to raise awareness about PGO, and to give job seekers the opportunity to learn about the company[245].	Silesian University of Technology, PGO	PL
Dual learning programme	The Department of Mechanical Engineering of the Silesian University of Technology has partnered with CMC Poland Sp. Z to provide a one-year dual learning programme combining academic training and in-firm practice[246].	Silesian University of Technology, CMC Poland Sp. z	PL
Joint programme on metallurgical technologies	AST Terni has recently concluded a partnership with the University of Perugia to jointly organise a three-month programme in Metallurgical and Steel Technologies. The programme is targeted at students in their last year of industrial engineering, who receive training on stainless steels by the AST production managers. Students are taught about the processes to produce a variety of stainless steel products, and are also involved in several plant visits during the course of their training[247].	University of Perugia, AST	IT

Table 19 — Industry-led initiatives for skills development

Name	Description	Organisation involved	Country
ZainSTALuj się	ZainSTALuj się is a scholarship and training programme for students run by ArcelorMittal Poland, for those who would like to enter the steel industry. The scheme is offered at three of ArcelorMittal Poland's sites: Krakow, Dabrowa Gornicza, Bytom[248].	ArcelorMittal Poland	PL
ElektroStart	The ElektroStart project consists of a three-month training for electrical	Celsa Group	PL

[245] Interview notes - Industry Stakeholders, senior-level representative at PGO
[246] See: https://www.cmc.com/de/global/cmccareers/spark-your-career/benefitseurope?crawlerid=6f34e000-8817-433b-8d45-1a51cbcb02fd&cidhash=75cc5d6398abc74fd81d1fbf5fe81dc78b450d3c835d599ce3977f1a4baccf2c, Last visited on 14.06.2019
[247] Siderweb, "Terni, AST e università insieme per la crescita", 27.02.2019, See: https://www.siderweb.com/articoli/industry/702203-terni-ast-e-universita-insieme-per-la-crescita, Last visited on 14.06.2019
[248] See: http://www.zainstalujsie.pl/, Last visited on 14.06.2019

Name	Description	Organisation involved	Country
	graduates and students promoted by the Celsa Group[249].		
Techport	Techport is the Dutch Smart Industry field lab, established to develop, test and implement Smart Industry solutions and transformations in the Netherlands. Techport was established in 2015 as part of Techniekpact, bringing together 11 partners including companies, schools, knowledge centres, public authorities and governments[250]. Techport designs and implements demand-driven technical curricula and supports innovative joint industries projects. The activities carried out by Techport include awareness-raising campaigns, workshops, and courses for school pupils. The project is co-financed by the European Regional Development Fund (ERFD)[251].	Tata Steel Europe, Province of Noord-Holland and other partners	NL
Job Swap	The Job Swap programme was established in 2017 to provide thyssenkrupp employees with the opportunity to exchange places with a colleague from a different part of the company for a specific amount of time. The aim of this initiative was to upskill the workforce and strengthen overall collaboration at company level[252].	thyssenkrupp	Global
tk Talents	The thyssenkrupp Talents programmes offers development opportunities to professionals and managers with above-average performance. The initiative aims to promote diversity, as well as motivate and empower a talented workforce to ultimately increase the company's retention rate. In the 2017/2018 fiscal year, more than 1,500 new talents were identified (900 more than in 2016/2017)[253].	thyssenkrupp	Global
thyssenkrupp Academy	The thyssenkrupp Academy is driving the Group's transformation with business-focused strategic and cultural programmes. In the 2017/2018 fiscal year the thyssenkrupp Academy made good progress with the establishment of its Global Functional Team Learning & Transformation (GFT L&T), comprising all the Group's internal learning providers. Among other things, the learning	thyssenkrupp	Global

[249] Interview notes - Education Providers, Associate professor at the Silesian University of Technology
[250] Smart Industry field labs are public private partnerships established to develop, test and implement Smart Industry solutions and transformations in the Netherlands. Techport was established as the result of the Techniekpact (Technology Pact), and brings together 11 industrial and academic partners.
[251] See: https://www.techport.nl/leren/, Last visited on 14.06.2019
[252] See: https://engineered.thyssenkrupp.com/en/job-swap-seeing-the-world-from-a-different-perspective/, Last visited on 14.06.2019
[253] See: https://www.thyssenkrupp.com/en/company/sustainability/employees/qualifications-training-and-development-of-talent/, Last visited on 14.06.2019

Name	Description	Organisation involved	Country
	programmes for skills and capabilities needed in all business areas were expanded. Together, learning providers ensure that a core curriculum specifically for thyssenkrupp is available everywhere[254].		
Outokumpu Technical Graduate programme	Outokumpu has a technical graduate programme for recent graduates with a master's degree in material science, engineering and metallurgy. The three-year programme familiarises graduates with Outokumpu's technical processes. During the programme, graduates build their skills by working independently with multiple technical assignments[255].	Outokumpu Oyj	FI, SE, DE
Summer internships	In addition to the dual learning programme with the Silesian University of Technology, CMC Poland Sp. Z also cooperates with the Czestochowa University of Technology and the AGH University of Science & Technology in Cracow, organising summer internships for students and providing one-on-one mentorship with their employees[256]	CMC Poland Sp. Z	PL
Steelmaster and Eurosteelmaster	Steelmaster and Eurosteelmaster are advanced courses for managers, researchers, students, trade union representatives and other professionals operating across the value chain of the steel sector from all over Europe. The courses are organised by RINA Consulting – Centro Sviluppo Materiali S.p.A. with the support of the European Commission, EUROFER, Federacciai and ESTEP[257,258].	RINA Consulting – Centro Sviluppo Materiali, European Commission, EUROFER, Federacciai and ESTEP	IT
Stahlstiftung Voestalpine	Stahlstiftung Voestalpine is a foundation created by Voestalpine's member companies, which aims to provide former employees of the Voestalpine group and other companies professional reorientation though training and continuous education. The foundation is entirely funded by member companies. Its activity revolves around professional orientation and VET[259].	Voestalpine	AT

[254] See: https://www.thyssenkrupp.com/en/company/sustainability/employees/qualifications-training-and-development-of-talent/, Last visited on 14.06.2019
[255] See: https://www.outokumpu.com/en/careers/outokumpu-graduate-programs/technical-graduate-program, Last visited on 14.06.2019
[256] See: https://www.cmc.com/de/global/cmccareers/spark-your-career/benefitseurope?crawlerid=6f34e000-8817-433b-8d45-1a51cbcb02fd&cidhash=75cc5d6398abc74fd81d1fbf5fe81dc78b450d3c835d599ce3977f1a4baccf2c, Last visited on 14.06.2019
[257] See: https://www.rina.org/it/media/events/2018/10/01/steelmaster, Last visited on 15.05.2019
[258] See: https://www.rina.org/it/media/events/2019/04/01/eurosteelmaster, Last visited on 15.05.2019
[259] See: https://www.stahlstiftung.at/stahlstiftung, Last visited on 14.06.2019

Name	Description	Organisation involved	Country
Dual Vocational Training programmes	Sidenor has been carrying out numerous dual vocational training programmes to enable future workers to combine education and work experience. The company regularly signs agreements with education providers to ensure that talented students can continue their training with the company[260].	Sidenor	ES
Rewind	Rewind is the national programme launched by the FIM-CISL metalworkers' union to promote bottom-up skills development programmes within steel companies. Each steel company where the union is represented has nominated a training officer, who is in charge of surveying the skills needs of workers and finding the most suitable training solutions[261].	FIM-CISL	IT
steeluniversity	The association steeluniversity has designed a wide array of e-learning courses and simulations to build skills in different fields, including technical, managerial, and business skills. Several e-learning modules and simulations focus on the business management of a steel company. Additional areas include transversal skills such as leadership, communication and marketing. Finally, the programmes of steeluniversity also promote the application of steelmaking skills in downstream industries (e.g. automotive, packaging, construction). The goal of steeluniversity is to provide education providers and companies with the right tools to train their students and staff. The courses of steeluniversity make ample use of serious games and simulations. Although platform users are growing worldwide, steeluniversity does not appear to be well-known in Europe[262]. According to a steeluniversity representative, the main obstacles include lack of awareness, as well as a motivational and cultural barrier[263].	World Steel	Global

To facilitate the provision of specific skills that are needed in the steel industry and, more broadly, in the metallurgical industry, projects have been launched at EU level. EU-funded projects often reflect the priorities of the European agenda, fostering environmental footprint reduction, circular waste usage and energy efficiency.

[260] Interview notes - Industry Stakeholders, Senior representative at Sidenor Spain
[261] See: https://www.fim-cisl.it/tag/rewind/ and https://www.youtube.com/watch?v=6xtZF2rwlr0, Last visited on 14.06.2019
[262] See: https://steeluniversity.org/, Last visited on 14.06.2019
[263] Interview notes - Education Providers, Senior representative from steeluniversity

Table 20 — EU funded projects to upskill and reskill workers

Name	Description	Organisation involved	Country
CIRRUS: Circular Residue Usage in Metallurgical Industry	CIRRUS is a three-year project revolving around the provision of structured lifelong learning education on the use of secondary raw materials in iron and steelmaking (and the production of other metals). New courses aimed at graduates and professionals are organised and delivered in different countries to promote enlarged engineering capacity and T-shaped profiles with broad knowledge on material properties and processes[264].	Swerea MEFOS AB, KU Leuven, Luleå University of Technology, Luossavaara-Kiirunavaara AB, Swerea AB and University of Oulu	BE, FI, SE
GT-VET: Greening Technical-Vocational Education and Training	The project aimed to develop VET curricula that meet environment, health and safety skills needed in the steel industry. GT-VET developed an industry-driven sustainable training module for industrial, mechanical, electrical and electronic technicians, in correspondence with the national VET systems of four European countries (Germany, Italy Poland, and the UK). The module was designed to be adapted to other technical professions and production industries, and is still being used: a first transfer was done in the automotive value chain with the GREEN STAR project[265]	12 partners, leader SFS – TU Dortmund	BE, DE, GR, IT, PL, UK
ESSA - "New Skills Agenda Steel": Industry-driven sustainable European Steel Skills Agenda and Strategy	ESSA is the Blueprint project launched in 2019 under Erasmus+. ESSA's main objective is to develop a Blueprint for a sustainable, steel industry-driven and coordinated 'European Steel Skills Agenda'. The project will devise a strategy for meeting current and future skills demands and pilot the development of modules and tools for building awareness and implementing new skills for a globally competitive industry. The aim is to be ready to anticipate new skills demands and to develop pro-active practical activities to meet the future requirements of the industry[266].	24 partners, leader SFS – TU Dortmund	EU-wide
Kiezen Voor Kansen Den Haag	The Kiezen Voor Kansen Den Haag (Opting for opportunities in the Hague) project brings together companies and education providers of the Hague to encourage young students to participate in internships in sectors facing occupational shortages and thereby discover sectors and jobs that they might not have known about otherwise. The project is financed through the ERDF[267].		NL

[264] See: https://eitrawmaterials.eu/events/course-circular-residue-usage-in-the-metallurgical-industry/, Last visited on 14.06.2019
[265] See: https://www.estep.eu/estep-at-a-glance/involvement/gt-vet/, Last visited on 14.06.2019
[266] See: https://www.estep.eu/essa/essa-project/objectives/, Last visited on 14.06.2019
[267] See: https://www.kansenvoorwest2.nl/nl/projecten/, Last visited on 14.06.2019

Name	Description	Organisation involved	Country
Verbonden met Zuid	Also, financed through the ERDF, the Verbonden met Zuid project (Connected to the South) brings together early school leavers older than 16, who are unemployed and without qualifications, employers from sectors such as healthcare and technology with vacancies to fill, and education providers. Together, they design and develop tailored apprenticeships for unemployed young adults[268].		NL

4.4.3. Best practices

Cooperation is key for the upskilling and reskilling of employees. Whilst most steel-relevant education is provided by companies in-house and on-the-job, stakeholders acknowledge the importance of seeking collaborations between the industry, public bodies and education providers. Industry representatives and education providers would welcome greater engagement from public authorities. They believe that policies aiming to support the development of skills and competencies for the workforce could contribute to addressing their needs for suitable profiles. However, they are also aware that due to the specificities of the sector and of the individual company, ad-hoc courses and training have to be provided in-house. Ideally, the implementation of national strategies about the Industry 4.0 or about the upskilling and reskilling of the industry should be carried out at regional level and involve a dialogue among relevant stakeholders. "The most effective activities for the steel sector can be implemented at the regional level"[269]. This seems to be a best practice in the Netherlands at Techport in North Holland[270], where stakeholders from different fields cooperate to devise measures and initiatives based on local needs and local resources.

Besides the interactions between policy makers and industry stakeholders, close contacts between professionals in the steel sector and education providers from relevant disciplines and programmes (STEM, engineering, materials science, chemistry and physics, etc.) is paramount to ensure that people with the right skills, background and knowledge enter the labour market. Although the focus of schools and universities may be on educating T-shaped individuals with a broader skillset, steel professionals can provide ad-hoc lectures or organise events to showcase their work to students who may otherwise be unaware of it or biased against it. Additionally, the cooperation between industry and academia is essential to facilitate the creation of dual education programmes. Dual education and alternation school-work appear to be one of the most effective methods to provide the future workforce with the needed competencies and know-how, while at the same time familiarising them with the industry. This is a win-win for students and companies as students get the opportunity to experience real technical challenges, obtain knowledge as well as on-the-job learning through mentoring and coaching. Companies benefit as younger generations can inject new knowledge into companies, making older workers familiar with novel processes and technologies. As dual education is not well established in all Member States, it should be promoted via policies and at company level as a best practice using success stories as an evidence of its effectiveness.

Considering the results from the industry stakeholder survey, the study also suggests that several educational and engagement measures are favourably regarded by respondents as

[268] See: https://www.europaomdehoek.nl/projecten/verbonden-met-zuid, Last visited on 14.06.2019
[269] Interview notes - Industry Stakeholders, Senior representative at the Instytut Metalurgii Żelaza im. St. Staszica in Poland
[270] Techport is a network of entrepreneurs, education providers, municipalities, the province and regional partners from the region who collaborate to promote technical skills and make manufacturing and maintenance industry sustainable and smart.

possible useful interventions to tackle skills needs. Respondents were asked to score how a list of ten potential training up-/reskilling options could help them meet their needs. The study first aimed to test whether these options can be grouped under higher level constructs (factors). The results of the dimension reduction method showed that nine (of the ten) options[271] could be grouped under three factors. The first factor appears to comprise the more "standard" options like on the job training, coaching and formal training. The second factor includes two rather less typical methods (e-learning and task rotation systems). The final factor is made of options that require more "external" activities (go to events, work with public authorities, provide opportunities to external people like students).

Table 21 — Factor analysis for up-/reskilling measures

Rotated Component Matrix[a]

	Component		
	1	2	3
Q30_r1: Offering regular on-the-job training (informal training)	.076	.800	.143
Q30_r2: Developing coaching or work-pair systems (master-apprentice) to facilitate knowledge transfer	.141	.712	.067
Q30_r3: Offering regular formal training to the workforce	.193	.658	.240
Q30_r4: Offering the workforce opportunities for self-learning and/or e-learning	-.040	.280	.743
Q30_r5: Adopting task rotation systems	.287	.098	.710
Q30_r6: Providing work experience opportunities for young people still at school	.725	.122	.292
Q30_r7: Providing work experience opportunities for people following university courses	.748	.004	.407
Q30_r9: Working with public authorities and education providers to develop a framework for continuous professional development	.549	.462	.049
Q30_r10: Participating in career events to make students aware of steel-related careers	.687	.244	-.222

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalisation.

a. Rotation converged in seven iterations.

The descriptive statistics in Table 22 (below) show that options in factor 2 score less than the options in the other factors. Overall, all the options score well and they are in the positive territory.

[271] The extraction level of one of the variables was low so it was removed from the factor analysis.

Table 22 — Descriptive statistics for up-/reskilling measures

Descriptive Statistics

	N	Min	Max	Mean	Std. Dev.
Q30_r1: Offering regular on-the-job training (informal training)	194	1	5	4.22	.868
Q30_r2: Developing coaching or work-pair systems (master-apprentice) to facilitate knowledge transfer	196	1	5	4.21	.867
Q30_r3: Offering regular formal training to the workforce	196	2	5	4.10	.898
Q30_r4: Offering the workforce opportunities for self-learning and/or e-learning	192	1	5	3.84	1.093
Q30_r5: Adopting task rotation systems	192	1	5	3.73	1.134
Q30_r6: Providing work experience opportunities for young people still at school	190	1	5	4.11	.972
Q30_r7: Providing work experience opportunities for people following university courses	190	1	5	4.12	.915
Q30_r8: Partnering with education providers at various level to help them develop industry-based courses	186	1	5	4.19	.871
Q30_r9: Working with public authorities and education providers to develop a framework for continuous professional development	191	1	5	4.04	.939
Q30_r10: Participating in career events to make students aware of steel-related careers	186	1	5	4.12	.901

Besides dual education and the other up-/reskilling interventions mentioned above, lifelong learning should be promoted among current workers to keep them challenged and up-to-date.

> *"It is important to look at informal ways of learning as well: there is a big potential, but this is very much linked to company culture – employees should be able to visit technical exhibitions, read technical journals. This is not the state of the art in all departments. Hence, there is room for improvement – there are some best practices, but they are not visible. One should also check other industries to see how they are doing it. This is above all a problem of mindset though: this kind of learning only works if the learner is willing to make use of it, it cannot be imposed on people. It is crucial to look at practices that foster a mindset of lifelong learning – you never terminate the learning, which makes you able to meet future needs"*[272].

Thinking of future needs and moving back to good practices for multi-stakeholder cooperation, it is worthwhile to consider the benefits that the exchange between industry representatives and labour offices, career counselling institutions and external research centres can bring to companies in terms of skills anticipation capacities. Overall, companies seem to be lacking effective foresight methods to predict future skills needs and address them earlier on. In most cases, recruitment is performed based on an assessment of current needs and does not always respond to a forward-looking and long-term strategy. Greater interaction with labour offices, career counselling institutions and external research centres studying skills gaps and skills needs would help companies define a strategy for

[272] Interview notes - Industry Stakeholders, Leading representative at thyssenkrupp Europe Training Centre

recruitment and employee retention and organise courses for upskilling or reskilling unemployed people who may fit companies' needs.

In addition to tapping into the pool of unemployed people who could be reskilled or upskilled to match the requirements of the industry, steel companies should also look into developing inclusive and gender equality policies. Women represent a large but currently underused pool of potential workforce. Infrastructure investments may be needed to make the work environment more suitable for women. Furthermore, campaigns should be promoted to showcase their gender-equality approach and the opportunities that exist for female workers.

5. CONCLUSIONS

This chapter summarises the main findings of the study and formulates general conclusions based on these findings. Furthermore, the strengths and limitations of the methods adopted are considered and suggestions for further research are presented.

The research carried out in the framework of this study presented an overview of the current situation of the steelmaking workforce in Europe, with a specific focus on skills supply and demand. Through a combination of qualitative and quantitative research, the study analysed stakeholders' perceptions concerning the image of the steel industry, focusing on perceptions and biases affecting the availability of labour. The analysis also looked into the most needed skills in the industry, focusing on both current and future needs. This was complemented by an analysis of current and future skills gaps and possible factors that drive these gaps. Finally, the study provides an overview of the available policies and initiatives to promote skills that are relevant to the steel sector, as well as an assessment of the educational system in different Member States with regards to the competencies needed by the industry.

As the number of jobs in steelmaking is expected to decrease over the next decade, the industry's occupational structure is undergoing significant changes. The labour demand is shifting towards profiles with higher levels of qualifications and skills. As production processes are being transformed by the integration of digital technologies, traditional organisation of work is giving way to more dynamic models. Rigid hierarchical structures are being replaced by small operational teams that act more autonomously but exchange larger amounts of information with one another. In light of this change, employers in the steel industry seem to favour profiles with wider adaptable skillsets, who have the necessary flexibility to navigate comfortably in a work environment characterised by an increased amount of decision-making and a high diversification of tasks.

Roles requiring repetitive work are gradually disappearing and workers are required to be able to perform multiple tasks across the production area and understand how the tasks they are performing fit in the overall functioning of the steel plant. While specialised operational skills to perform specific tasks are still considered important, findings suggest that employers prefer profiles with T-shaped skillsets, including an area of specialisation complemented with a series of transferable skills. The latter include a solid general technical background, a good command of digital technologies and computer use, and skills such as critical thinking, complex problem solving, and independent decision-making. As they are progressively relieved from manual tasks, operators will be required to control machines remotely and intervene to ensure the smooth running of operations. Hence, the importance of skills like critical thinking, problem-solving, and decision-making is elevated. Engineering profiles will be required to step out of a purely technical role and integrate decision-making with people management skills as well as a stronger customer orientation and understanding of commercial aspects related to the products.

Manual skills are still considered important but will become less relevant in the future. Conversely, digital and managerial skills are expected to increase in importance, stemming from the fact that new trends such as Industry 4.0 will further drive the transformation of production processes. Workers will be required to interact proficiently with automated plant facilities and interpret large amounts of data to take informed decisions. As the European industry is taking steps to enhance the quality of production in compliance with EU standards, awareness about practices linked to material recycling and resource optimisation is expected to become more relevant for workers in production areas.

The industry's investment in training and education is considered to be low or not strategic enough, being rather focused on responding to urgent, immediate needs. Many companies seem to lack effective foresight methods to anticipate future skills needs. In addition, European companies, on average, appear to be affected by a poor learning culture, which influences both management (with many companies still considering training as a cost rather than an investment) and employees (fear of change and delays in adaptation with

respect to new technologies, especially among the older employees). Companies remain the most suitable place to learn sector-specific competencies, while educational programmes taught at universities and VET schools appear to provide wider sets of competencies. Industry-specific degrees have become rarer due to low enrolment numbers and the increasing industry demand for more varied and wider skillsets. In the long run, university degrees that are specifically orientated to the steel industry are progressively being eliminated or replaced by more general degrees focused on a wider skillset. The latter requires firm-specific training to be then applied to the steel industry.

Against the backdrop of changes mentioned above, the European steel industry is confronted with considerable shortages of qualified personnel. As its workforce approaches the age of retirement, the sector fails to attract enough new talents to cater to its needs, especially when it comes to specialised engineering and technical profiles. The image of the sector is still that of an old-fashioned industry with poor working conditions and little prestige. This contributes to driving away many young talents, especially those with highly relevant STEM backgrounds, who tend not to consider careers in steelmaking. While older workers have more difficulties in integrating new technologies and processes, their technical know-how is not harnessed fully as they often retire without passing on their knowledge to younger employees. In an industry that heavily relies on informal education, such lack of knowledge transfer represents a considerable issue. Some companies have taken action to improve the overall attractiveness of the sector and to leverage untapped pools of talents such as women and migrants to face the shortage of skilled labour. However, steelmaking is still regarded as a largely male-dominated industry and issues related to discrimination based on gender or race are factors affecting the ability of the industry to attract new talent.

More forward-looking strategies, based on stronger collaboration between the industry, public bodies and education providers, are needed to find and retain talents and to up-/reskill the workforce. Despite acknowledging that most industry-specific skills can only be learned on the job through one-on-one mentoring, the industry has a vested interest in keeping close contacts with the relevant faculties and vocational institutions that represent important reservoirs of skilled labour. Dual education and alternation school-work are effective tools to familiarise students with the industry and increase their job-readiness level. Partnerships between companies and educational institutions are increasing, with companies engaging in apprenticeship schemes and giving students the possibility to carry out traineeships or use companies as case studies for their thesis. In general, the industry would welcome a more comprehensive approach to dual learning with impetus provided by good policymaking. In all the analysed national cases, national and regional policies have a cross-sectoral scope and do not specifically tackle the steel industry. Stakeholders, however, acknowledge the role of policies in the smart industry area (e.g. national strategies on Industry 4.0) and in the education area (on the way manufacturing industries approach training and lifelong learning). In this sense, stronger cooperation with policy makers would help create a supportive framework for the industry, provided that the necessary steps are taken to ensure that policies are implemented through regional plans, engaging with companies at the local level.

Without claiming to be exhaustive, this study aimed to provide a clear state-of-play analysis of the situation of the European steel sector with regard to skills gaps and needs. Rather than a standalone document, this report intends to serve as the starting point for more comprehensive research, which could build upon the major trends and developments highlighted here to add new analytical dimensions to the issue of skills demand and supply in the steel sector. In line with the objectives of the 'Blueprint for sectoral cooperation on skills', the research carried out in the framework of this study should feed into a more comprehensive skills taxonomy, which will be developed by the newly-formed sectoral alliance of the ESSA project.

6. RECOMMENDATIONS

Based on the findings of the study, this chapter offers a series of recommendations for different stakeholders, including policy makers, sectoral trade associations, trade unions, steel companies as well as education and employment services providers, for addressing the skills needs of the European steel industry. The chapter also provides communication recommendations for improving the image of the sector.

6.1. Policy recommendations

Building on the findings presented in Chapter 4 and the conclusions of Chapter 5, a series of recommendations has been developed. Each recommendation describes the rationale behind it, possible concrete initiatives and the stakeholders that would ideally be involved to achieve the desired result.

- **Monitor and anticipate steel industry skills needs** — Setting up common European tools for skills needs monitoring and anticipation would be an efficient measure that would benefit the entire European steel industry. It would allow the EU and national policy makers to take more informed decisions, education providers to adjust the curricula of educational programmes accordingly, companies to develop and implement better informed hiring and skills development strategies and employment services providers to promote the opportunities in the steel industry to candidates with skills that are increasingly required by the sector. This would be helpful in minimising time lags between the introduction of an innovation and the provision of suitable training, an aspect that was found to be at the origin of skills gaps in the steel sector. Specific initiatives could for example include:
  - At EU level:
    - EU-wide skills needs monitoring and anticipation and the tools for it should be prioritised and addressed. Cooperation could be sought between stakeholders at the EU level to create a centralised EU observatory for the steel industry for this purpose. Existing cross-sectoral platforms could be leveraged, for instance Cedefop's Skills Panorama or ESCO (European Skills, Competences, Qualifications and Occupations). The observatory would ideally publish regular reports on current and future skills needs on the basis of data provided by the companies in the sector. A best practice to take inspiration from could be the "Observatoire paritaire, prospectif et analytique des métiers et des qualifications de la métallurgie"[273], created by French social partners to provide information on the evolution of skills and jobs related in metallurgy.
  - At regional, national and company level:
    - A strong engagement could be sought among trade associations and trade unions at national level to promote the platform among their members. A national intermediary could be appointed for each Member State that would be responsible for making the content of the Observatory available in the national language. In addition, cooperation should be sought with regional authorities (for instance via the Committee of the Regions) and ministries, to promote the observatory among public education and employment services providers.

- **Provide and promote training in transferable skills** — In the context of constant and rapid changes in the job market, measures are necessary to ensure that the steelmaking workforce has skills that can be applied in different professional contexts. Designing programmes aimed at building transversal competencies would allow the metalworkers to rapidly and successfully adapt to new requirements, technologies and modes of working. Specific initiatives could for example include:

[273] See: https://www.observatoire-metallurgie.fr/, Last visited on 29.03.2020

- At EU level:
  - As transferable skills are by definition relevant for various sectors and countries, the steel industry should, to the extent possible, make use of training resources already developed for the provision of – for instance – soft and digital skills. Sectoral organisations at the EU level would then be well placed to adapt these training resources to the context of the steel sector, if needed, and make them available to the stakeholders in the sector. E-learning modules or other digital formats would be a particularly viable format in this respect as they can be easily adapted and used in different organisations, sectors and countries. An example of good practice here could be steeluniversity[274], a collection by the World Steel Association of free-to-use e-learning resources, including on transferable skills.
- At regional, national and company level:
  - Education providers, trade unions and companies that carry out training activities could be incentivised to incorporate these resources into their training activities. This could be done by building on previous experiences in agreement with national and local VET systems, following the example of projects such as GT-VET[275].
  - National contact points could be identified in each Member State for translating and disseminating the content of the training material in their own national context.

- **Expand and promote on-the-job forms of training** — As many of the stakeholders pointed out during the course of the study, initial education and training can at most provide a basis of knowledge for what is an increasingly dynamic job environment. Workers of the future will have to engage in lifelong learning and on-the-job forms of training represent some of the most effective methods for the provision of needed knowledge and skills. While numerous companies (and trade unions) already run such training programmes, there is room for improvement in terms of sharing examples of good practice and jointly developing training resources that are certified for workers to have their skills more widely recognised. Specific possible actions could for example include:
  - At EU level:
    - A repository of on-the-job training programmes and practices could be created at the EU level. It would serve a dual purpose. Firstly, it would allow the organisations that carry out on-the-job training, i.e. companies, trade unions and education providers, to learn from examples of good practice. On the other hand, companies could explore partnership possibilities in terms of on-the-job training, e.g. develop joint courses or provide mobility opportunities for employees. This would create new networking opportunities and allow workers to be exposed to different perspectives and lines of work, which would be beneficial for their personal and professional development. To overcome possible challenges regarding IPR and competition, the repository could be set up as a training database with certified offers, which companies could leverage for internal education. Certifications would be important to guarantee workers' mobility, ensuring that their skills are widely recognised even beyond the specific company where they have been trained.
    - Regular assessments of the initiatives in the repository should be carried out in order to identify barriers and success factors as well as highlight best practices to encourage their implementation by other organisations across the sector.

[274] See: https://steeluniversity.org/, Last visited on 29.03.2020
[275] See : https://www.estep.eu/estep-at-a-glance/involvement/gt-vet/, Last visited on 09.04.2020

- At regional, national and company level:
  - National associations and trade unions could be encouraged to sponsor joint training initiatives, in order to ensure a maximum level of participation from workers.
  - Financial incentives (possibly in the form of grants or funding under EU-programmes) could be awarded to companies that are willing to engage in joint training schemes, especially those undertaken with companies active in other Member States.

- **Promote (reverse) mentorship as a way of knowledge transfer between older and younger workers** — Large segments of workers being on the brink of retirement is one of the urgent challenges the steel industry is facing. Mentorship appears to be a particularly viable method of ensuring that valuable knowledge is not lost in the process and is appropriately transferred to younger generations of workers. On the other hand, young people bring in valuable skills in their own right that they can share with their more senior colleagues, particularly in terms of digital skills. Consolidating and further expanding mentorship programmes, whenever possible in the form of reverse mentoring, therefore must be a crucial part of any forward-looking education and training strategy. Specific initiatives could for example include:
  - At EU level:
    - It would be beneficial to collect and share examples of good practice in mentorship programmes at the EU level. Based on those examples, it would also help the companies to have European guidelines for setting up effective (reverse) mentorship schemes.
    - Building on the European guidelines for validating non-formal and informal learning created by Cedefop, steel companies and associations could develop a common label to validate forms of guidance such as counselling and mentoring. A certificate could be awarded to businesses that could demonstrate for instance that they have a structured approach to mentoring, monitor the functioning of such programmes, provide training for mentors and individual-level certificates to mentors and mentees, etc.
    - Sectoral organisations at the EU level could support the scheme to ensure a high level of participation of companies in mentoring schemes.
  - At regional, national and company level:
    - National trade unions and trade associations, as well as individual trade unions, could play an important role in raising awareness about the certification scheme.
    - Regional and national authorities could be encouraged to support companies to develop in-house mentorship programmes. The ESIF, especially the European regional development fund (ERDF) and the European social fund (ESF), could be valuable instruments in this respect.
    - As part of the certification scheme, companies should provide certifications to employees participating in the programme, both mentors and mentees. While the latter could use it to boost their employability, the former could benefit from an official recognition of their expertise in a given field, which could motivate them to take a more active role in the knowledge transfer process.
    - Companies in the sector across the EU could create a pool of senior experts who can provide advice or work on specific projects as interim managers even after they retire, following the example of thyssenkrupp's Senior Experts initiative.

- **Encourage exchanges between public authorities, education providers and steel companies to promote digital and advanced technology skills, dual education and lifelong learning** – New technological trends such as Industry 4.0 are expected to disrupt work organisation across the whole spectrum of manufacturing industries. At the current stage, it is difficult to accurately pinpoint how skills and professional profiles will be affected by the advancements that AI

and IoT will bring into CPS. However, many stakeholders involved in this study agreed that current skills gaps are caused by the increased use of digital technologies in steel plants (see linear regression model for Survey 1, perception of current skills gaps, Table 13). There is a need for increased coordination between companies, vocational schools, universities and local governments to reach a common understanding of how to address the economic and social challenges of the Fourth Industrial Revolution. This study has highlighted several best practices in this regard, including dual learning and hybrid education schemes, apprenticeships for high school and university graduates, and strategic public-private alliances. Additionally, lifelong learning should be acknowledged as a right (and required asset) for workers and promoted systematically, continuously and widely. All these practices would help address one of the statistically significant factors that likely causes skills gaps, i.e. the lack of suitable educational programmes (see Table 13). Specific initiatives could include:

- At EU level:
  - Thematic multistakeholder forums should be organised, gathering businesses, sectoral organisations, vocational and higher education providers networks, universities, research centres and representatives from the European institutions and national governments. These forums should highlight the central role of digital technologies in achieving the priorities of the EU as well as foster the debate on how to integrate the provision of digital skills for the manufacturing sector in existing programmes.
  - Guidelines should be developed to support coordinated policymaking by Member States concentrating on Industry 4.0 and digital transformation requirements for skills development.
  - In addition, sectoral guidelines for the provision of digital skills as part of the on-the-job training within companies should be developed and widely promoted.
  - Member States should be provided with the tools to harmonise policies and practices related to lifelong learning.
- At regional, national and company level:
  - Industry-driven skills alliances with vocational schools, universities and local authorities in high industrial activity areas should be incentivised, building on the example of existing best practices such as the Smart Industry field labs in the Netherlands.
  - Lifelong learning and dual education should be promoted as best practice among education providers and steel companies at regional and local level.

- **Promote social dialogue to ensure that as many workers as possible are included in skills development strategies** — New trends such as Industry 4.0 and the green transition come with a risk of exclusion for medium- and low-skilled profiles. Educational programmes also need to be adapted to different skill levels and roles. This calls for structured interventions at company and trade union levels, aimed at mitigating the risk of imbalances in training opportunities available to workers. Measures to support and guide low- and medium-skilled workers in the digital transition should be developed, building on a strong policy action both at the EU and national level. Actions to ensure that no one is left behind may include:
  - At EU level:
    - Social partners could be actively involved on sectoral skills to ensure that future strategies do not lose sight of low- and medium-skilled workers.
    - Existing initiatives such as the Sectoral Social Dialogue Committee on Steel and the ESTEP Working Group People could be leveraged to develop learning modules adapted to low- and medium-skilled workers.
  - At regional, national and company level:
    - Local trade unions should be included in the design of on-the-job training programmes.
    - National, regional and local authorities could be encouraged to financially support the trade unions that provide training for their members, for

example through the ERDF and the ESF. Possible best practices are represented by the network "Innovazione Apprendimento Lavoro" created by CISL in Italy or "Communitas", the educational arm of Community Union in the UK.

- **Include underrepresented groups, such as women and migrants** — As the steel industry becomes less labour-intensive, non-traditional groups can also be tapped into for skilled labour. Women are by far the largest untapped group of talent to work in manufacturing. Findings from the study's surveys suggest that they would be interested in working in the sector but feel that the infrastructure and work culture are not suitable. Another group that remains majorly untapped are migrants, particularly refugees. They are often highly qualified, but their qualifications are rarely recognised in Europe. Recognition of prior learning for migrants should therefore be ensured at the EU level in general. In Member States with high immigration rates such as Germany, the integration of refugees is addressed at policy level and through ad-hoc company-led alliances. To fill this gap while ensuring equal treatment, different steps could be taken:
  - At EU level:
    - A study on the level of inclusion of women and migrants in the European steel sector workforce, as well as the potential for its improvement, would be beneficial. The study would compare different Member States on the basis of their ability to harness their potential and so potentially generate healthy competition across Europe. A baseline for this type of study and the related steps is provided by the research report of the Equality and Diversity Learning in the European Steel Industry (EDLESI) project.[276]
    - Awareness-raising campaigns for companies in the sector across the EU could be conducted by sectoral organisations, highlighting the manifold benefits, including economic, of including these underrepresented groups.
    - European guidelines on aspects related to discrimination and integration would support steel businesses in integrating and retaining new groups of workers.
    - Best practices in inclusion of underrepresented groups conducted at national, regional or company level could be collected and shared at the level of the EU. In addition, sectoral organisations at the EU level could recognise best practices with an award.
  - At regional, national and company level:
    - Efforts to promote job opportunities in the steel sector to underrepresented groups by companies and employment services providers should be intensified.
    - Steel companies should ensure that their HR teams are adequately trained to better integrate new groups and fight discrimination. The equality awareness training package for firms produced in the EDLESI project could be a baseline for this.
    - Anti-discrimination campaigns should be conducted among existing workers to fight against gender and race discrimination in the workplace.
    - Steel companies should be encouraged to invest in infrastructure interventions that aim to create a more inclusive workplace. These measures should include providing adequate physical infrastructure, like for instance changing rooms, and catering to different dietary requirements.

[276] Fairbrother, P., Kruse, W., Stringfellow, E., Stroud, D., Tech, D. and Winterton, J., "Equality and Diversity Learning in the European Steel Industry, A Report for LEONARDO DA VINCI Community Vocational Training Action Programme Second phase: 2000-2006", Cardiff: Cardiff University, 2007, pp. 162-166

6.2. Communication recommendations

The findings of Chapter 4 also allowed for the development of communication recommendations. These could be used to optimise communication activities in the steel sector, improve the overall image of steelmaking careers, and attract talented professionals to the industry.

- **Emphasise the prominence of steel in every aspect of modern society**
  Target audience: ICT and environment science graduates with no previous exposure to the steel sector; possibly also school leavers who may be encouraged to attend a vocational school instead of a university degree
  Reasoning: Steelmaking is among the leading industrial sectors that are driving innovation in the digitalisation and greening of European economies. Steel companies are carrying out cutting-edge research to meet the EU's targets on climate, and trends such as Industry 4.0 require talented professionals for ICT and technological research. However, according to stakeholders in the industry, the general public seems to be largely oblivious of this and underestimates the importance of steel in modern life, whilst skilled young people seem unaware of the dynamism of the industry. It is key to provide target audiences with a clear image of the relevance of steel products in everyday life as well as the large extent to which most industrial sectors rely on steel. A best practice could be the #lovesteel campaign launched by World Steel.

- **Increase visibility of high-skilled positions that are non-labour intensive and require cross-functional skills**
  Target audience: All, with a specific focus on the groups who consider physical work a reason not to work in the steel industry
  Reasoning: One of the main misconceptions around steelmaking jobs is that they are physically tiring and low-skilled careers. The development of automated processes has significantly reduced manual labour and physical stress associated with steel production chains. There is little to no direct contact with the cast product. According to the study results, this transition is not (yet) reflected in jobseekers' perceptions about the sector, suggesting a potential communication gap. Communication initiatives should highlight how many qualified positions relate to analysis and decision-making rather than just physical work. It is particularly relevant for people who cannot or do not wish to perform physical activities in the workplace. Task variety should be emphasised and relevance should be given to positions that enable the employee to alternate physical work with office work. This resonates with the results from the CBC analysis (the feature "type of work" comes second, after the "type of contract"; the mixed nature of work is the attribute with the greatest positive average utility within the feature). Highlighting the growing relevance of ICT-related positions could also help attract new talents, as our results suggest a strong relationship between the willingness to work in the sector and the belief that steel careers require digital skills.
  Similarly, the challenging features of engineering careers in the sector should also be enhanced. Smarter companies offer exciting challenges for the employees, but this is not always clear to people who do not work in the sector. However, this is an additional factor that can drive the willingness to work in the sector (see Table 4). It is also paramount to showcase the opportunities for professional growth and progression within the sector and the good level of remuneration (relative to other employment in a plant's locality), as these have also been found to be statistically significant factors that can drive the willingness to work in the steel sector. Finally, language can play a role in changing the perception of steel careers, especially if the industry is looking to recruit from beyond its traditional talent pools; for instance shifting from the traditional word "worker" to "employee" can help revert negative associations with physically demanding work.

- **Showcase the role of steel in reaching circular economy and sustainability goals**
  Target audience: Jobseekers interested in sustainability and green economy
  Reasoning: The linear regression model for Survey 2 suggests that the belief that steel companies make efforts to increase their sustainability could increase people's willingness to work in the sector. By its very nature steelmaking is polluting, but great efforts are being made to make the industry sustainable. The European steel industry is actively reducing its environmental footprint to meet the EU climate targets for 2050, with companies involved in cutting-edge R&D initiatives. More visibility should be given to initiatives valuing the use of steel in practices such as reuse and remanufacturing. As steel is durable and versatile, it is 100% recyclable and can be re-used multiple times without losing any of its properties. It plays a key role in achieving sustainable circular economies based on the re-use and recycling of resources. Nowadays, the vast majority of steel by-products are being reused and repurposed, and 40% of European steel production is based on the recycling of scrap steel. In addition, research on high-strength steels has led to a 25% to 40% weight reduction in the steel products used in cars, buildings and packaging, leading to significant cuts in emissions and energy use. The research results suggest that jobseekers might be unaware of these significant facts, which constitutes a missed opportunity to improve perceptions and attract more people to work in the sector. R&D work on reducing the industry's ecological and carbon footprints and achieving alignment with environmental regulations should be foregrounded as an employment opportunity aimed at attracting emerging experts in the field.

- **Help jobseekers understand how advances in AI and robotics will reshape the work organisation of the industry**
  Target audience: Those who have not worked in the sector before
  Reasoning: As machines and assisting robots are used in production areas more frequently, direct human contact with the cast product will continue to decrease, with more employees operating in the control room. Advances in CPS will also favour remote sensing and control processes, gradually allowing operators to supervise production remotely. As a consequence, shift models are expected to evolve, becoming more flexible and allowing to alternate on-site presence with home working. Given the low attractiveness of shift work, especially among certain groups of people (e.g. cluster 4 see Chapter 4.2.2), it is important to raise awareness on how novel technologies and approaches will disrupt work organisation for several engineering and technical positions. For some, a prestigious occupation is an important determinant to increase their willingness to work in the steel sector. A focus on this aspect could attract more candidates. Furthermore, showing the complexity of an Industry 4.0 environment can help increase the respect that the general public has for the sector. Last, but not least, showcasing the smart, digital aspects of the industry would help better align the perceived skills needs of industry professionals with those of students, graduates and jobseekers, who seem to feel that manual skills are more relevant in the steel sector, while digital and data skills are less relevant.

- **Showcase the industry's efforts towards health and safety**
  Target audience: All
  Reasoning: One common perception that can negatively affect the appeal of the steel sector is the perceived lack of health and safety conditions. Steelmaking is still considered a dangerous occupation that should be remunerated with high salaries and early retirement. To counter this misconception, communication efforts should also focus on health and safety measures undertaken by steelmaking companies, including both in-firm courses and actual changes in the company policies and infrastructure to minimise work hazards. Factsheets with basic statistics could be used for communication. As suggested by the empirical results, candidates who are convinced that steel companies care about their workers' safety and working conditions are significantly more likely to be willing to work in the sector (cf. Table 4).

- **Establish partnerships with innovative steel companies to show what modern plants look like**
  Target audience: All
  Reasoning: When thinking about steel plants, many people still picture a dirty, unwelcoming work environment, characterised by loud noises and sewage smells. Over the years, many steel companies have made substantial investments in infrastructure, and more and more plants are becoming state-of-the-art facilities. As pointed out by company representatives involved in this study, working in a steel plant for qualified employees is comparable to working in a laboratory. To counter the negative misconception on steelworks' poor working conditions, communication initiatives should focus on highlighting what the daily work of technicians, operators and engineers employed in control and maintenance positions really looks like. Furthermore, there should be campaign showcasing the progress made in improving working conditions in steel plants over the past years.

- **Carry out campaigns promoting careers in metallurgy and STEM-related studies in primary schools and high schools**
  Target audience: Primary school and high school pupils
  Reasoning: Some steel companies are tackling the challenge of talent shortage early on, engaging with primary schools and high schools to increase the attractiveness of STEM-related careers and make pupils (particularly girls) more familiar with manufacturing (particularly the steel sector). Partnerships should be sought with high schools and technical schools to implement activities aimed at raising awareness on steelmaking via field visits to steel plants, open days with employees, workshops and cultural activities, and more. Existing initiatives by government and the civil society to support young people's and women's engagement in STEM subjects could also be leveraged. Companies should work to re-establish links with the local communities in the areas where production sites are located. Relevant major STEM-based disruptors (e.g. DIY movement, collaborative production initiatives) could be an interesting agent or vehicle that steel-related communications can potentially exploit to 'sense' or even create talent while boosting awareness.

- **Encourage companies to use their employees as ambassadors in communication campaigns**
  Target audience: All
  Reasoning: Findings show that, apart from a general poor image of the sector, many people (including people with educational backgrounds that could be relevant to work in a steel company) have little to no awareness of the variety of career opportunities offered by steelmaking. To counter this trend, one noteworthy initiative is Why #Ilovesteel, launched by World Steel as part of the #lovesteel campaign. The initiative comprises a series of videos with employees from World Steel members (all working in diverse roles) explaining what they love about their jobs. Building on this best practice, EU-level communication campaigns could leverage sectoral organisations such as EUROFER to identify ambassadors in positions that are expected to be in high demand in the industry, such as production managers, maintenance and automation engineers, data governance specialists, design and energy engineers, metallurgists, line technicians and mill operators. Showing the working conditions of steel companies from within could help convince stakeholders who are moderately willing to work in the sector, but do not find it attractive (see Cluster 1 in Chapter 4.2.2). These campaigns should not only target graduates and jobseekers, but also address undergraduates and employees with entry level positions, who seem to find the steel sector unattractive (cf. Clusters 2 and 3 in Chapter 4.2.2). 4.2.2

7. ANNEXES

7.1. Annex 1: Implementation roadmap - Building the necessary skills for the EU steel industry

Building on the results of the study "European vision on steel-related skills of today and tomorrow"[277] and the conclusions and recommendations stemming from these as well as the input of experts in the steel sector[278], the present implementation roadmap puts forward specific actions to be taken in order to build the necessary skills base for the EU steel industry. Actions range from data collection and analysis to curriculum building and communication campaigns, among others, and are divided into three thematic groups:

- **Monitor skills needs**
- **Improve the image of the sector and careers within it**
- **Include underrepresented groups, such as women and migrants**

Each thematic group contains a set of specific actions and each action is indicated by a letter of the alphabet (A–I). Where relevant, actions are broken down into specific steps, marked accordingly with numbers (1–5). These steps logically follow each other in chronological order and each respective step is dependent on successful implementation of the one preceding it.

Furthermore, the time frame of each specific action is illustrated with arrows, within the range of the next five years (2021–2025). Actions that should be initiated promptly, either because subsequent steps depend on them or to allow sufficient time for their completion, are additionally highlighted with a different colour (darker shade). The time allocated to each action is of indicative nature and may have to be adjusted, as required by internal and external factors.

For each proposed action, a stakeholder category is designated that would ideally be in charge of its implementation, keeping in mind that as many sectoral stakeholders should be involved as possible and appropriate. Actions to be completed will often have to be initiated at the highest instance and require collaboration at the EU level and then become increasingly more local in character, relating for instance to actions that are recommended to be taken by individual firms in the sector.

Finally, the implementation roadmap also puts forth the relevant tools and/or financial mechanisms that could potentially be employed to ensure effective and efficient implementation of each of the proposed actions.

It is important to note that the creation of the necessary skills base for the EU steel industry cannot leave education and training out of consideration. Therefore, the present roadmap is complemented by the '**Implementation roadmap: Towards EU Education and Training on steel industrial technology skills'** that can be found in Annex 7.2.

[277] Available online here: https://publications.europa.eu/s/mVKl.

[278] Input was collected through dedicated workshops in seven target countries (i.e. Finland, France, Germany, Italy, the Netherlands, Poland and Spain) and two webinars.

Monitor skills needs

Having a solid knowledge base is fundamental for designing informed, appropriate measures, policy and otherwise, including when it comes to skills in the steel sector. As noted in the recommendations part of the study, a dedicated knowledge bank would allow policy makers to design effective evidence-based public policies, employment services providers to connect the candidates with the required skillsets to employers in the sector as well as businesses themselves to get a better view on how the job market is evolving and act accordingly.

--- 2021	--- 2022	--- 2023	--- 2024	--- 2025

A1. Create a centralised EU observatory on steel industry skills needs

***Who**: Collaboration of stakeholders at the EU level, e.g. Cedefop, ESTEP, EUROFER, IndustriALL etc. – Through the European Social Dialogue for steel*

***How**: By relying on existing (or forthcoming) European platforms (such as Skills Panorama, the European Platform for Digital Skills and Jobs) and/or by leveraging the outputs of the European Steel Skills Agenda Project*

A2. Promote the observatory to companies to ensure it is populated with data

***Who**: Sectoral organisations at the EU and national level*

***How**: Through organisations' existing communication channels*

A3. Populate the observatory with data on skills needs

***Who**: Companies in the sector across the EU*

***How**: By leveraging companies' own resources*

A4. Analyse the data, form conclusions and publish reports

***Who**: Abovementioned EU-level stakeholders*

***How**: By relying on existing (or forthcoming) European platforms (such as Skills Panorama, the European Platform for Digital Skills and Jobs) or by liaising with the European Steel Skills Agenda Project*

A5.1 Promote the observatory to ensure that its findings are disseminated and used

***Who**: EU bodies, sectoral organisations at the EU and national level*

***How**: Through stakeholders' existing communication channels*

A5.2 Develop policies based on the findings of the observatory

***Who**: EU and national policy makers*

***How**: By taking into account the reports published by the observatory*

--- 2021	--- 2022	--- 2023	--- 2024	--- 2025
A5.3. Adjust the curricula of educational programmes in line with the findings of the observatory				
***Who**: Education providers*				
***How**: By taking into account the reports published by the observatory; possibly, leveraging funding opportunities such as the European Social Fund Plus (ESF+)*				
A5.4 Develop and implement informed hiring and skills development strategies				
***Who**: Companies in the sector across the EU*				
***How**: By leveraging companies' own resources*				
A5.5 Promote the opportunities in the steel sector to candidates with required skillsets				
***Who**: Employment services providers, companies in the sector across the EU*				
***How**: By leveraging employment services providers' and companies' existing channels*				

A1. Create an EU observatory on steel industry skills needs

In order to effectively monitor skills needs and mismatches that are likely to be common to the European steel industry as a whole, a skills observatory should be created at the EU level. The observatory should not only collect the data on current skills needs but also use the data to anticipate skills needs in the future. To ensure efficiency, existing cross-sectoral platforms could be used for this purpose, for instance Cedefop's Skills Panorama. This would require collaboration of sectoral organisations at the EU level, such as the European Steel Technology Platform (ESTEP), the European Steel Association (EUROFER), IndustriALL European Trade Union, with Cedefop. The European Social Dialogue for steel would be an appropriate platform for devising this action in detail. The outputs of the European Steel Skills Agenda Project could also be leveraged, particularly when it comes to skills anticipation mechanisms.

A2. Promote the observatory to companies to ensure it is populated with data

To ensure that the observatory is in fact populated with data on skills, the abovementioned stakeholders, as well as their national counterparts, should sufficiently promote it to companies in the steel industry that identify skills needs through their operations. The benefits of the observatory should be clearly promoted to ensure companies' participation in the data collection activities.

A3. Populate the observatory with data on skills needs

Provided that action A2 is effectively implemented, companies that encounter skills needs would then populate the observatory with the relevant data. The data could take various forms, for instance of descriptions of the needed profiles or specific skills, survey data etc.

A4. Analyse the data, form conclusions and publish reports

Based on the collected data, stakeholders in charge of the observatory would then periodically form conclusions and publish reports. Anticipation of skills needs in the future should be an integral part of such reports. The reports should focus on commonalities in the data whereupon individual companies and other organisations could use the findings in devising their own specific strategies and activities.

A5.1 Promote the observatory to ensure its findings are disseminated and used

To ensure that the findings are disseminated and taken into account by all the relevant stakeholders, i.e. EU and national policy makers, education providers, companies and employment services providers, the observatory should be widely promoted. The observatory should become a commonly accepted, centralised location that is used extensively and consistently by the sector as a whole. The stakeholders in charge of the repository, as well as their national counterparts, should therefore leverage their communication channels to a maximum to achieve this objective.

A5.2 Develop policies based on the findings of the observatory

The EU and national policy makers should take the findings of the observatory into account when designing policies, in particular those related to education.

A5.3. Adjust the curricula of educational programmes in line with the findings of the observatory

Education providers should adjust the curricula of educational programmes in line with the findings of the observatory. For this purpose, they could potentially leverage funding opportunities such as the European Social Fund Plus (ESF+).

A5.4 Develop and implement informed hiring and skills development strategies

Companies in the sector across the EU should develop and implement hiring and skills development strategies in line with the findings of the observatory.

A5.5 Promote the opportunities in the steel sector to candidates with required skillsets

Employment services providers and companies in the sector should make sure to promote the opportunities in the steel sector to candidates that have the skills that are required by the sector currently or in the future.

Improve the image of the sector and careers within it

During the course of the study, the image of the steel sector, in line with that of the wider manufacturing industry, emerged to be one of the major factors that prevent businesses from hiring sufficient numbers of workers with the needed skillsets, particularly among the profiles that up until recently were not associated with the sector but are now increasingly sought after, such as Information Technology experts. Improving the image among the wider public, including in relation to issues of environmental sustainability, is therefore a prerequisite to bridging the existing skills gap in the steel industry.

--- 2021	--- 2022	--- 2023	--- 2024	--- 2025

B1. Develop an EU-wide communication campaign to improve the image of the steel industry

***Who**: EUROFER in collaboration with social partners at the EU level*

***How**: By leveraging resources of EUROFER and its members*

B2. Adapt the campaign to local contexts, creating a set of communication materials that companies could use for enhancing recruitment

***Who**: Trade associations at national level*

***How**: By leveraging resources of trade associations and their members*

B3. Conduct the campaign in Member States

***Who**: Trade associations at national level*

***How**: By leveraging resources of trade associations and their members*

C. Advertise job opportunities in the steel industry to candidates of varied disciplines

***Who**: Companies in the sector, employment services providers*

***How**: By leveraging companies' and employment services providers' own resources*

D. Advertise good working conditions in the steel industry

***Who**: Companies in the sector, employment services providers*

***How**: By leveraging companies' and employment services providers' own resources*

E. Promote the steel sector in primary and secondary schools

***Who**: Collaboration between companies in the sector and primary and secondary education providers*

***How**: By leveraging companies' and education providers' own resources, possibly drawing from the European Social Fund Plus (ESF+)*

B1. Develop an EU-wide communication campaign to improve the image of the steel industry

To ensure efficiency and amplify the message, an EU-wide communication campaign should be developed with the objective of improving the image of the steel industry. The campaign should target the general public and address aspects related to environmental sustainability, health and safety at work, and digitalisation. The European Steel Association (EUROFER) is regarded as best placed to lead on this action. Nonetheless, social partners at the EU level should be involved to ensure that a variety of perspectives are included in the messaging.

B2. Adapt the campaign to local contexts

The campaign should be adapted to local contexts of the different Member States, both in terms of the language as well as the content itself, to ensure that it is relevant for the varied local markets. Trade associations at national level could take on this role, by leveraging their own resources and those of their members. Trade associations could develop template materials that companies could use as part of their recruitment campaigns.

B3. Conduct the campaign in Member States

As the final step of action B, the campaign would be carried out in preferably all the Member States, again under the leadership of national trade associations.

C. Advertise job opportunities in the steel industry to candidates of varied disciplines

In addition, companies in the steel industry as well as employment services providers should advertise specific job opportunities in the sector to candidates of varied disciplines, not only metallurgy, for instance Information Technology, environmental sciences, law etc. These candidates have been targeted only in a limited manner until now and are consequently not well aware of the different opportunities in the steel industry, despite their skillsets being in demand there.

D. Advertise good working conditions in the steel industry

Working conditions are a major factor in the choice of a career. The good working conditions that the steel industry can offer, particularly in terms of salary and benefits, as well as opportunities for further training, professional development and mobility, should therefore be widely advertised by the companies in the sector as well as employment services providers. Even when the conditions may not be considered optimal compared to those of other sectors due to the specificities of steel production, it would be advisable to show the great progress that has been made over time, for instance adding digital and robotics elements to the steel production plants and processes or in terms of sustainability.

E. Promote steel sector in primary and secondary schools

People would ideally be familiarised with the steel industry early on, including in primary and secondary schools. Young students could for instance be introduced to the steel sector in general through field visits to steel plants, open days with employees, workshops or similar, whereas vocational education and specific career opportunities within the sector should be promoted when it becomes relevant to students' career choices. This action would require collaboration between companies in the sector and primary and secondary education providers. The European Social Fund Plus (ESF+) could potentially be leveraged for the purpose.

Include underrepresented groups, such as women and migrants

The study suggests that rather large groups of potential workers, such as women and migrants, remain majorly untapped due to traditional perceptions of steel production as a predominantly male and local industry both among job seekers themselves as well as among the workers and employers within the sector. In the context of unsatisfied skills needs and large segments of workers on the brink of retirement, the steel industry cannot afford to continue towards the future with such a restricted pool of potential candidates. It would therefore benefit from putting in place measures that would attract and integrate these underrepresented groups.

--- 2021	--- 2022	--- 2023	--- 2024	--- 2025
F1. Conduct a study on inclusion in the EU Member States				
***Who**: Collaboration of stakeholders at the EU level such as EU bodies (e.g. Eurostat), sectoral organisations (e.g. EUROFER) and relevant NGOs (e.g. European Network Against Racism (ENAR), European Women's Lobby (EWL)) etc.*				
***How**: By leveraging organisations' existing data or by launching a call for proposals for a dedicated study, possibly drawing from the Research Fund for Coal and Steel (RFCS)*				
F2. Conduct an awareness-raising campaign on the benefits of including underrepresented groups				
***Who**: Sectoral organisations at the EU level*				
***How**: By leveraging organisations' own resources and leaning on results of the study, possibly liaising with the European Steel Skills Agenda Project*				
G1. Design European guidelines for companies on aspects related to discrimination and better integration of new groups in the workplace				
***Who**: Collaboration of stakeholders at the EU level such as EU bodies, sectoral organisations (e.g. EUROFER) and relevant NGOs (e.g. European Network Against Racism (ENAR), European Women's Lobby (EWL)) etc.*				
***How**: By leveraging organisations' own resources, possibly in combination with funding sources such as the European Social Fund Plus (ESF+)*				
G2. Provide training for Human Resources teams on aspects related to discrimination and better integration of new groups in the workplace				
***Who**: Companies in the sector in collaboration with experts on the topic*				
***How**: By leveraging companies' own resources and leaning on the guidelines*				
G3.1 Implement company policies on aspects related to discrimination and better integration of new groups in the workplace				
***Who**: Companies in the sector*				
***How**: By leveraging companies' own resources and leaning on the guidelines*				

--- 2021	--- 2022	--- 2023	--- 2024	--- 2025

G3.2 Conduct anti-discrimination campaigns among workers

***Who**: Companies in the sector*
***How**: By leveraging companies' own resources and leaning on the guidelines*

H1. Collect and share best practices in inclusion of underrepresented groups conducted at national, regional or company level

***Who**: Sectoral organisations at the EU level*
***How**: By leveraging organisations' own resources*

H2. Organise an award to recognise companies or other organisations with best practices in inclusion of underrepresented groups

***Who**: Sectoral organisations at the EU level, for instance ESTEP Working Group "People"*
***How**: By leveraging organisations' own resources*

I. Promote job opportunities in the steel sector to underrepresented groups

***Who**: Companies in the sector, employment services providers*
***How**: By leveraging companies' and employment services providers' own resources*

F1. Conduct a study on inclusion in the EU Member States

In order to collect baseline data and establish a common understanding, a study on the level of inclusion of women and migrants in the European steel sector workforce, as well as the potential for its improvement, would be beneficial. Specific considerations in relation to refugees as a particular group of potential recruits should be examined in greater detail, also due to legal implications of their stay in a specific country. In addition to sectoral organisations, such as the European Steel Association (EUROFER), certain EU bodies, like Eurostat, or NGOs, like the European Network Against Racism (ENAR) or European Women's Lobby (EWL), could either aggregate their existing data or collaborate on a dedicated study for this specific purpose. A dedicated call for proposals could also be launched, possibly drawing from the Research Fund for Coal and Steel (RFCS).

F2. Conduct an awareness-raising campaign on the benefits of including underrepresented groups

Equipped with the data from the study foreseen as action F1, sectoral organisations at the EU level could then conduct an awareness-raising campaign for companies in the sector across the EU, highlighting the manifold benefits, including economic, of including these underrepresented groups. The European Steel Skills Agenda Project could be helpful in this respect. Larger campaigns at national or EU level, such as Women in Tech initiatives, could also be leveraged to this purpose.

G1. Design European guidelines for companies on aspects related to discrimination and better integration of new groups in the workplace

To be able to successfully integrate and retain new groups of workers, steel businesses need to put adequate conditions in place. To aid them in this effort, EU bodies, sectoral organisations and relevant NGOs at the EU level should design relevant guidelines, possibly drawing from the European Social Fund Plus (ESF+).

G2. Provide training for Human Resources teams on aspects related to discrimination and better integration of new groups in the workplace

To the extent that this is needed, Human Resources teams within the steel businesses should receive training to be able to effectively address aspects related to discrimination and better integration of new groups in the workplace. Companies in the sector should draw on support from the experts on this topic in providing such training.

G3.1 Implement company policies on aspects related to discrimination and better integration of new groups in the workplace

On the basis of the European guidelines and the training received, Human Resources teams within the steel businesses would then be able to design and implement company policies on aspects related to discrimination and integration. These measures should include providing adequate physical infrastructure, like for instance changing rooms, and catering to different dietary requirements.

G3.2 Conduct anti-discrimination campaigns among workers

Inclusion of new groups might also require addressing the discrimination that women and migrants might encounter in until now relatively homogenous workplaces. In-house anti-discrimination campaigns carried out by the companies in the sector could be beneficial in this respect.

H1. Collect and share best practices in inclusion of underrepresented groups conducted at national, regional or company level

Sectoral organisations could promote the inclusion of underrepresented groups also by collecting and sharing best practices in this area. They could leverage their existing communication channels for this purpose, for instance their websites.

H2. Organise an award to recognise companies or other organisations with best practices in inclusion of underrepresented groups

On the basis of the collection of documented best practices in inclusion of women and migrants, sectoral organisations at the EU level could periodically recognise companies or other organisations implementing such practices with an award. This would provide visibility of such practices across the European steel industry, promote their implementation as well as provide an additional incentive for companies to hire and integrate underrepresented groups. The award may be undertaken by recognised bodies such as ESTEP Working Group "People".

I. Promote job opportunities in the steel sector to underrepresented groups

With appropriate conditions put in place, the European steel industry should also increase efforts to attract these underrepresented groups. Employment services providers could aid them in this respect. An important aspect of this effort is also to ensure the recognition of prior learning for migrants, especially for refugees, which should take place at the EU level in general.

7.2. Annex 2: Implementation roadmap - Towards EU Education and Training on steel industrial technology skills

Building on the results of the study "European vision on steel-related skills of today and tomorrow"[279] and the conclusions and recommendations stemming from these as well as the input of experts in the steel sector[280], the present implementation roadmap puts forward specific actions to be taken in order to provide and improve education and training offer for the steel industry. Actions range from mapping the existing training resources to developing and promoting new ones, among others, and are divided into three thematic groups:

- **Provide and promote training in transferable skills**
- **Expand and promote on-the-job forms of training and learning**
- **Promote (reverse) mentorship as a way of knowledge transfer between older and younger workers**

Each thematic group contains a set of specific actions and each action is indicated by a letter of the alphabet (P–V). Where relevant, actions are broken down into specific steps, marked accordingly with numbers (1–6). These steps logically follow each other in chronological order and each respective step is dependent on successful implementation of the one preceding it.

Furthermore, the time frame of each specific action is illustrated with arrows, within the range of the next five years (2021–2025). Actions that should be initiated promptly, either because subsequent steps depend on them or to allow sufficient time for their completion, are additionally highlighted with a different colour (darker shade). The time allocated to each action is of indicative nature and may have to be adjusted as required by internal and external factors.

For each proposed action, a stakeholder category is designated that would ideally be in charge of its implementation, keeping in mind that as many sectoral stakeholders should be involved as possible and appropriate. Actions to be completed will often have to be initiated at the highest instance and require collaboration at the EU level and then become increasingly more local in character, relating for instance to actions that are recommended to be taken by individual education providers or firms in the sector.

Finally, the implementation roadmap also puts forth the relevant tools and/or financial mechanisms that could potentially be employed to ensure effective and efficient implementation of each of the proposed actions.

The present roadmap is complemented by the '**Implementation roadmap: Building the necessary skills for the EU steel industry**' that can be found in Annex 7.1.

[279] Available online here: https://publications.europa.eu/s/mVKl.

[280] Input was collected through dedicated workshops in seven target countries (i.e. Finland, France, Germany, Italy, the Netherlands, Poland and Spain) and two webinars.

Provide and promote training in transferable skills

In the context of constant and rapid change, skills that can be acquired in one setting and transferred to another represent the necessary toolbox of a contemporary worker. The steel industry is no exception in this trend and therefore has to ensure adequate provision of the so-called soft skills, such as flexibility and teamwork, as well as more and more notably digital skills.

--- 2021	--- 2022	--- 2023	--- 2024	--- 2025
P1. Map existing training resources in transferable skills				
***Who**: Stakeholders at the EU level, e.g. Cedefop, DG EAC etc.*				
***How**: For instance, by launching a call for tenders or proposals under the Erasmus+ programme*				
P2. Develop relevant training resources that are not yet available from other sources, including e-learning modules				
***Who**: Education providers*				
***How**: By employing the resources appropriated to the call for proposals or leveraging funding programmes such as Erasmus+ or the European Social Fund Plus (ESF+)*				
P3. Adapt training resources to the context of the steel sector				
***Who**: Sectoral organisations at the EU level e.g. ESTEP, EUROFER, IndustriALL etc.*				
***How**: By leveraging organisations' own resources or through the European Steel Skills Agenda Project*				
P4. Promote the existing and newly developed training resources to potential users				
***Who**: Sectoral organisations at the EU level e.g. ESTEP, EUROFER, IndustriALL etc.*				
***How**: Through organisations' existing communication channels*				
P5. Incorporate the relevant training resources into training activities				
***Who**: Education providers, trade unions and companies relevant to the sector*				
***How**: By leveraging organisations' own resources*				
P6. Provide certificates of acquired transferable skills to learners				
***Who**: Education providers, trade unions and companies relevant to the sector*				
***How**: By leveraging organisations' own resources*				
Q1. Organise thematic multistakeholder forums to debate how to ensure adequate provision of digital skills				
***Who**: ESTEP*				
***How**: For instance through the European Steel Skills Agenda Project*				

--- 2021	--- 2022	--- 2023	--- 2024	--- 2025
Q2. Develop sectoral guidelines for the provision of digital skills				
***Who**: ESTEP*				
***How**: For instance through the European Steel Skills Agenda Project*				
Q3. Promote sectoral guidelines for the provision of digital skills				
***Who**: ESTEP*				
***How**: Through existing communication channels of ESTEP and its members*				

P1. Map existing training resources in transferable skills

As transferable skills are by definition relevant for various sectors, and are increasingly recognised as important, numerous training resources have already been developed for the provision of transferable skills, either in the form of (online) training courses or training materials such as books, brochures, videos etc. A comprehensive mapping of such resources, to the extent that this is possible, would allow to benefit from those resources and ensure efficiency. Stakeholders dealing with education and skills development matters at the EU level, such as Cedefop and/or DG EAC, would be best placed to lead on this action, for instance by launching a call for tenders or proposals under the Erasmus+ programme. This action should be closely linked to action A1, presented in Annex 7.4 - 'Implementation roadmap: Building the necessary skills for the EU steel industry' and aimed at monitoring skills needs to make sure that the training resources identified under P1 are actually relevant to current and future skills needs.

P2. Develop relevant training resources that are not yet available from other sources, including e-learning modules

Potential gaps in training resources identified through mapping as part of the action P1 should then be addressed by developing the missing ones. E-learning modules or other digital formats are a particularly viable option for this purpose as they can be easily adapted and used in different organisations, sectors and countries. Also in this case, a close link should be maintained with action A1, presented in Annex 7.4. The various education providers could potentially leverage EU funding opportunities for this purpose, such as Erasmus+ or the European Social Fund Plus (ESF+), or alternatively this activity could be part of the abovementioned call for proposals.

P3. Adapt training resources to the context of the steel sector

The training resources in transferable skills that will be fairly general in character should then, whenever needed, be adapted to be more relevant for the specific context of the steel sector, for instance by adding sector-specific examples and terminology. Sectoral organisations at the EU level, such as the European Steel Technology Platform (ESTEP), European Steel Association (EUROFER) and IndustriALL European Trade Union could implement this action for the European steel industry as a whole, potentially through the European Steel Skills Agenda Project. Once again, adaptations should be matched with the monitoring of skills needs in the steel sector (action A1 in Annex 7.4) to ensure their relevance and effectiveness.

P4. Promote the existing and newly developed training resources to potential users

To ensure that both previously existing and newly developed training resources are in fact used in training activities, the abovementioned stakeholders should also ensure that these resources are promoted to potential users, i.e. education providers, trade unions and companies that carry out training activities. In doing so, sectoral organisations at the EU level can benefit from already established communication channels with education providers, trade unions and companies relevant to the sector.

P5. Incorporate the relevant training resources into training activities

Once aware of the relevant training resources, education providers, trade unions and companies that carry out training activities should incorporate these resources into their training activities, for instance by using educational videos in their existing training courses or by providing the access to e-learning modules to the learners.

P6. Provide certificates of acquired transferable skills to learners

Certificates of training courses taken and so acquired skills are increasingly appreciated in the labour market as they signal to employers which candidates have acquired in this case transferable skills or have at the very least taken a relevant course to initiate the process. On the other hand, they are also appreciated by learners themselves, which would act as an incentive for people to engage in and complete training activities. Education providers, trade unions and companies that carry out training activities should therefore ensure to award relevant certificates to learners that have completed these activities in a satisfactory manner.

Q1. Organise thematic multistakeholder forums to debate how to ensure adequate provision of digital skills

Digital skills are a particularly critical category of transferable skills. Therefore, it is important to devise a sector-wide plan to ensure their adequate provision. To bring together the various stakeholders from the steel industry, as well as experts in digital technologies and skills specifically, thematic multistakeholder forums could be organised. The European Steel Technology Platform (ESTEP) that brings together all the major stakeholders in the European steel industry is probably the best forum for this debate, possibly through the European Steel Skills Agenda Project that specifically deals with skills requirements related to the digital transformation of the industry. Debates at European level should be combined with debates at national level, which would help overcome possible language barriers and address national specificities.

Q2. Develop sectoral guidelines for the provision of digital skills

The input from the abovementioned multistakeholder forums should lead to the development of guidelines for the provision of digital skills for the European steel industry as a whole. These guidelines would support coordinated policymaking by Member States when it comes to national education and training systems as well as actions by private actors in relation to the provision of digital skills.

Q3. Promote sectoral guidelines for the provision of digital skills

To ensure that guidelines for the provision of digital skills are in fact taken into account and applied in practice, they should be widely promoted. The European Steel Technology Platform (ESTEP) with the established communication channels among its many members would in itself act as a potent means of promotion.

Expand and promote on-the-job forms of training and learning

As many of the stakeholders pointed out during the course of the study, initial education and training can at most provide a basis of knowledge for what is an increasingly dynamic job environment. Workers of the future will have to engage in lifelong learning and on-the-job forms of training represent some of the most effective methods for the provision of needed knowledge and skills. While numerous companies (and trade unions) already run such training programmes, there is room for improvement in terms of sharing examples of good practices, jointly developing training resources and involving workers to take ownership of their own learning.

--- 2021	--- 2022	--- 2023	--- 2024	--- 2025

R1. Create a repository of on-the-job training programmes and practices

***Who**: Sectoral organisations at the EU level e.g. ESTEP, EUROFER, IndustriALL etc.*

***How**: For instance by liaising with the European Steel Skills Agenda Project*

R2. Promote the repository to companies, trade unions and education providers to ensure it is populated with data

***Who**: Sectoral organisations at the EU and national level*

***How**: Through organisations' existing communication channels*

R3. Populate the repository with data on on-the-job training programmes and practices

***Who**: Companies, trade unions and education providers relevant to the sector*

***How**: By leveraging organisations' own resources*

R4. Identify examples of good practice

***Who**: Sectoral organisations at the EU level e.g. ESTEP, EUROFER, IndustriALL etc.*

***How**: By making use of data in the repository*

R5. Promote the repository and its findings to ensure best practices are disseminated across the sector

***Who**: Sectoral organisations at the EU and national level*

***How**: Through organisations' existing communication channels*

R6.1 Integrate best practices into training activities

***Who**: Companies and trade unions in the sector across the EU*

***How**: By leveraging organisations' own resources (possibly leveraging funding sources such as the European Regional Development Fund in countries that lag behind)*

--- 2021	--- 2022	--- 2023	--- 2024	--- 2025
R6.2 Explore partnership possibilities between companies - develop joint courses or provide mobility opportunities for employees				
***Who**: Companies in the sector across the EU*				
***How**: By leveraging companies' own resources or leveraging funding provided by programmes such as the European Social Fund Plus (ESF+) or Erasmus+*				
S. Communicate on the importance of lifelong learning				
***Who**: Sectoral organisations at the EU and national level, companies and education providers*				
***How**: By leveraging organisations' own resources and relying on existing platforms (such as the Lifelong Learning Platform)*				

R1. Create a repository of on-the-job training programmes and practices

To share examples of good practice and learn from them, a repository of on-the-job training programmes and practices should be created at the EU level. Accordingly, sectoral organisations at the EU level, such as the European Steel Technology Platform (ESTEP), European Steel Association (EUROFER), IndustriALL European Trade Union etc., are best placed to implement this action, possibly through the European Steel Skills Agenda Project.

R2. Promote the repository to companies, trade unions and education providers to ensure it is populated with data

To ensure that the repository is in fact populated with data on on-the-job training programmes and practices, the abovementioned stakeholders, as well as their national counterparts, should sufficiently promote it to organisations that carry out on-the-job training, i.e. companies, trade unions and education providers. The benefits of the repository for individual organisations should be made very clear to incentivise data collection and sharing.

R3. Populate the repository with data on on-the-job training programmes and practices

Provided that action R2 is effectively implemented, companies, trade unions and education providers that carry out on-the-job training would then populate the repository with the relevant data. The data could take various forms, for instance of programme descriptions, monitoring tools or training materials.

R4. Identify examples of good practice

From the collection of documented on-the-job training programmes and practices, the stakeholders in charge of the repository could then periodically highlight examples of good practice to encourage their implementation by other organisations across the sector. They could potentially present these examples through different communication tools, for instance through interviews with people responsible for the programme, case studies or other tools considered appropriate for the purpose.

R5. Promote the repository and its findings to ensure best practices are disseminated across the sector

To ensure that experiences are shared across the sector and that best practices are eventually implemented, the repository should be widely promoted. The stakeholders in

charge of the repository, as well as their national counterparts, should therefore leverage their communication channels to a maximum to achieve this objective.

R6.1 Integrate best practices into training activities

As the last step of action R and its final objective, organisations that carry out on-the-job training should integrate the identified best practices into their training activities. For this purpose, they could employ their existing resources or possibly leverage funding sources such as the European Regional Development Fund in countries that lag behind.

R6.2 Explore partnership possibilities between companies - develop joint courses or provide mobility opportunities for employees

Simultaneously, on the basis of the repository, steel businesses could explore partnership opportunities in terms of on-the-job training with other companies in the sector across EU. They could for instance consider developing joint courses, where appropriate, or provide mobility opportunities for employees, in order to stimulate their professional development. For this purpose, they could make use of their own resources or potentially leverage funding programmes such as the European Social Fund Plus (ESF+) or the Erasmus+.

S. Communicate on the importance of lifelong learning

Lifelong learning both at work and outside of it should be actively promoted by as many stakeholders as possible. Sectoral organisations at the EU and national level as well as individual companies and education providers relevant to the steel sector should therefore continuously stress its importance through various communication channels. In this effort, they could rely on existing platforms, such as for instance the Lifelong Learning Platform. However, greater visibility should be given to such platforms, which may not be widely known among stakeholders in the sector. To communicate on the importance of lifelong learning, it is considered essential to emphasise how the steel sector has changed in the past years and show the speed at which it keeps changing. While the velocity of evolution of the sector may make skill needs forecasts difficult, it also shows that the capacity to constantly learn and adapt is paramount. Synergies may also be sought with other industrial sectors to amplify the message.

Promote (reverse) mentorship as a way of knowledge transfer between older and younger workers

Large segments of workers being on the brink of retirement is one of the urgent challenges the steel industry is facing. Mentorship appears to be a particularly viable method of ensuring that valuable knowledge is not lost in the process and is appropriately transferred to younger generations of workers. On the other hand, young people bring in valuable skills in their own right that they can share with their more senior colleagues, particularly regarding digital skills. Solidifying and further expanding mentorship programmes, whenever possible in the form of reverse mentoring, therefore must be a crucial part of any forward-looking education and training strategy.

--- 2021	--- 2022	--- 2023	--- 2024	--- 2025

T1. Document good practices of mentorship programmes within companies

***Who**: Sectoral organisations at the EU level e.g. ESTEP, EUROFER, IndustriALL etc.*

***How**: As part of the repository of on-the-job training programmes and practices foreseen as action R*

T2. Develop guidelines for setting up effective (reverse) mentorship programmes

***Who**: Sectoral organisations at the EU level e.g. ESTEP, EUROFER, IndustriALL etc.*

***How**: As part of the repository of on-the-job training programmes and practices foreseen as action R*

T3. Promote best practices and guidelines for effective (reverse) mentorship programmes

***Who**: Sectoral organisations at the EU level e.g. ESTEP, EUROFER, IndustriALL etc.*

***How**: As part of the repository of on-the-job training programmes and practices foreseen as action R*

T4. Implement one-on-one (reverse) mentorship programmes

***Who**: Companies in the sector across the EU*

***How**: By leveraging companies' own resources*

U1. Create a certification for companies in the sector running one-on-one (reverse) mentorship programmes

***Who**: EUROFER*

***How**: By leveraging resources of EUROFER and its members*

U2. Promote the certification to companies

***Who**: Sectoral organisations at the EU level (e.g. ESTEP, EUROFER, IndustriALL), sectoral organisations at national level and individual trade unions*

***How**: Through organisations' existing communication channels*

--- 2021	--- 2022	--- 2023	--- 2024	--- 2025
U3. Provide certifications to individuals – mentors and mentees				
***Who**: Companies in the sector across the EU*				
***How**: By leveraging companies' own resources*				
V. Create a pool of senior experts who continue to share their know-how after retiring				
***Who**: Companies in the sector across the EU*				
***How**: By leveraging companies' own resources*				

T1. Document good practices of mentorship programmes within companies

To encourage the implementation of mentorship programmes on a wider scale, best practices in this respect should be documented and shared. For this purpose, the repository of on-the-job training programmes and practices foreseen as action R could be employed, run by EU-level sectoral organisations.

T2. Develop guidelines for setting up effective (reverse) mentorship schemes

Based on the examples of good practice, guidelines for setting up ad implementing mentorship and reverse mentorship at company level should be developed to formalise as much as possible the process and enhance its replicability.

T3. Promote best practices and guidelines for effective (reverse) mentorship schemes

The guidelines should be promoted, along with examples of good practice, to facilitate companies' development of mentorship programmes. Promotion could take place as part of action R5 through the channels of sectoral organisations at the EU and national level.

T4. Implement one-on-one (reverse) mentorship programmes

Wherever this is not yet the case, companies in the sector across the EU should implement one-on-one mentorship programmes and reverse mentorship schemes, following the guidelines developed as part of action T2, to ensure knowledge transfer between older and younger workers.

U1. Create a certification for companies in the sector running one-on-one (reverse) mentorship programmes

To encourage the implementation of the abovementioned mentorship programmes, a sectoral organisation at the EU level, preferably the European Steel Association (EUROFER), could create a certification for companies running such programmes. The certification would be awarded to businesses that could demonstrate for instance that they have a structured approach to mentoring, monitor the functioning of such programmes, provide training for mentors and individual-level certificates to mentors and mentees etc. The purpose of the certification would be to encourage mentorship programmes in a positive manner and would therefore not impose stringent requirements on companies.

U2. Promote the certification to companies to encourage the set-up of relevant mentorship programmes

To achieve the ultimate objective of action U, stimulate the set-up of mentorship programmes, active promotion of the certification to companies would be beneficial. Apart

from the European Steel Association (EUROFER), other sectoral organisations at the EU level, such as the European Steel Technology Platform (ESTEP) and IndustriALL European Trade Union, as well as sectoral organisations at national level and individual trade unions should participate in promotion efforts by leveraging their existing communication channels.

U3. Provide certifications to individuals – mentors and mentees

Certifications for individuals, both mentors and mentees, should be an integral part of the overall company certification. Companies that have a mentorship programme in place should provide certifications to employees participating in the programme, as both an incentive and a recognition.

V. Create a pool of senior experts who continue to share their know-how after retiring

Companies in the sector across the EU would benefit from creating their respective pools of senior experts who are interested in imparting their knowledge to younger generations even after they retire, following the example of Senior Experts GmbH founded by thyssenkrupp.

7.3. National profiles

7.3.1. Finland

The steel industry and its competitiveness

In 2017, Finland's steel production represented 2.4% of the steel produced in the EU (and 2.5% in 2016)[281]. According to data published by EUROFER, the production of crude steel in Finland has slightly increased between 2012 and 2017[282]. In 2012, 3.76 million tonnes were produced, rising to 4 million tonnes in 2017[283]. In terms of employment, the steel industry has also increased the number of direct jobs it provides. In 2016, the steel industry supported 7,800 direct jobs (as well as 37,100 indirect and 12,200 induced jobs), while in 2017 direct jobs amounted to 7,987[284].

The main Finnish steel producers are Outokumpu, Peikko, and Rautaruukki. These three companies with headquarters in Finland are multinational groups, with subsidiaries across Europe and the world. Outokumpu is one of the largest producers of stainless steel and employs over 11,000 people across 30 countries. The company merged with or acquired other companies before becoming a world player, such as the Swedish company Avesta, the Germany Lurgi Mettalugie and in 2012, Inoxum, the stainless-steel department of Thyssenkrupp. Rautaruukki also acquired different companies across Europe, for instance Metalcolour A/S (Denmark), and opened offices in China in 2009. These three Finnish companies reflect a trend in the metal sector – internationalisation and the creation of large multinationals.

According to a 2010 study[285], metal companies in Finland merged in response to a more competitive business environment. As their clients were merging, and their suppliers were increasingly bigger and more powerful, steel companies started merging to keep their bargaining power. Moreover, large steel companies tend to outsource a large part of their operations, with medium-sized companies seizing the opportunity to take on this work. This same study highlights the growing trend of relocations. Finnish metal companies are increasingly relocating their production sites to developing markets such as Asia and Eastern Europe. This trend does not only apply to mass production operations but also to the production of more specialised products and services as well as R&D. Some Finnish companies choose to remain in Finland but act globally, using ICT innovations to be closer to international markets. These trends are reflected in the structure of the three main Finnish steel companies, with a presence in different countries across the globe.

The Finnish steel sector was not affected by the US steel tariffs, as opposed to some other EU countries, as Finland only exports low quantities to the US. Indeed, cold-rolled steel is the 5th most exported industrial product for Finland, and less than 1% of it was exported to the American market[286].

The Finnish metal industry is characterised as becoming project-oriented and agile with the business model changing to an engineering-to-manufacturing model[287]. Companies focus on being closer to customers, giving importance to networking and relations with suppliers and customers as well as making full use of ICT possibilities. The steel industry

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[281] EUROFER, *European Steel in Figures 2017*, 2017
[282] *Ibid.*
[283] EUROFER, *European Steel in Figures 2018*, 2018
[284] *Ibid.*
[285] Iskanius P., Page T., Anbu S.P., "The traditional industry sector in the changing business environment – a case study of the Finnish steel product industry", *International Journal of Electronic Customer Relationship Management,* vol. 4, no. 4, 2010
[286] "Report: Finland's industrial sector in good shape", https://yle.fi/uutiset/osasto/news/report_finlands_industrial_sector_in_good_shape/10230662, Last visited on 07.05.2019
[287] Iskanius P., Page T., Anbu S.P., "The traditional industry sector in the changing business environment – a case study of the Finnish steel product industry", *International Journal of Electronic Customer Relationship Management,* vol. 4, no. 4, 2010

is facing challenges related to "speed, flexibility, increased product diversity and customisation"[288]. Experts predict that in the future, the Finnish metal sector will consist of "20 new global focal companies, 100 strategic partners, 200 growth-oriented companies aiming to be system suppliers and 500 SMEs to become specialised members of internationally operating networks"[289]. In this scenario, customisation and individualisation of production would be the main criteria for competitiveness in the future. To effectively offer customised and individualised products, steel companies will have to adopt an agile manufacturing model and establish privileged communication and cooperation with suppliers to meet customer demands.

Finland boasts a vibrant innovation ecosystem, based on strong cooperation between the industry and academia, whereby research results are regularly applied, and inventions gradually introduced in practice. Nonetheless, some of the challenges here include the disparity between the fast-changing needs of the industry versus the long-term oriented nature of research. Somewhat related to that is the issue of research funding, as the latter is available for too short periods of time. This is seen by national stakeholders involved in the study as an aspect that the EU can provide support with, for instance by ensuring that sufficient funding is available for long-term research and innovation projects, such as those funded under the Horizon 2020 programme.

Similarly, with regards to sectoral cooperation of multiple stakeholders on a national level with the purpose of strengthening the competitiveness of the sector in general, Finland can be characterised as an example of good practice. First of all, due to a productive dialogue among different entities, the country has a forward-looking national strategy in place. Secondly, stakeholders have active, largely informal connections to each other, due to the size of the sector as well as due to the fact that Finnish steel businesses are export-oriented, compete on the global market and are therefore not direct competitors to each other. Nonetheless, there is a potential room for improvement in terms of establishing a more formalised, systematic manner of collaboration.

As other potential avenues for further improving the competitiveness of the Finnish steel industry, national stakeholders involved in the study mention the creation of niche markets through specialisation and taking a flexible approach to production, thereby increasing productivity and volumes. Customer focus is again deemed essential to maintain the competitiveness and relevance of production.

In terms of the labour force, national stakeholders highlight the relatively high educational level of Finnish steel workers at all skill levels as an important competitive advantage. On the other hand, they note the unexplored potential of including women and migrants. This should not only entail creating the relevant positions and making them visible to these underrepresented groups, but also ensuring that they have access to the necessary pathways to be able to reach them, for instance in terms of educational opportunities.

On a political level, national stakeholders stress the importance of a supportive policy environment, particularly in terms of national and EU policy makers fostering a level playing field and fair competition. Indeed, issues related to trade are some of the main challenges for the Finnish steel industry due to its relatively higher production costs.

Current and future skills needs

The steel industry is faced with a constant and rapid change. For instance, Finland, like other EU countries, is experiencing a demographic change, with a large proportion of its active population becoming older and retiring or nearing retirement[290]. This trend is a threat to the country's skills base as the loss of manpower and expertise will need to be

[288] *Ibid.*, p. 395
[289] *Ibid.*, p. 401
[290] Iskanius P., Page T., Anbu S.P., "The traditional industry sector in the changing business environment – a case study of the Finnish steel product industry", *International Journal of Electronic Customer Relationship Management,* vol. 4, no. 4, 2010

made up for and the transfer of know-how ensured between the older and newer generations.

Although the overall number of workers in the sector is expected to decrease due to robotics and automation trends, particularly when it comes to blue-collar workers, the knowledge content of jobs in the steel industry is progressively becoming higher. The Finnish National Board of Education (FNBE) predicts that the number of expert occupations in traditional manufacturing sectors will in fact increase[291], meaning that these sectors will in the future employ a more highly skilled and specialised labour force. While fundamental knowledge needed to work in the steel industry does not change rapidly throughout the years, changes like the growing internationalisation of Finnish steel companies described above and the transition towards project-oriented business mean that new types of skills are increasingly needed for staff at all skill levels.

National stakeholders participating in the study and national policy documents, such as the current vocational education programme for Metalwork and Machinery[292], which can be pursued by students wishing to work in the steel sector, identify the following types of skills as crucial in the steel sector:

- Skills related to the production process: comprehensive basic skills in manufacturing techniques, mechanical drawing, machine installation and maintenance, as well as a specialised expertise in a certain area;
- Process skills: knowing the steps that come before and after one's specific task within the production process;
- Mathematical skills;
- Information Technology (IT)/digital skills;
- Environmental, Health & Safety (EHS) skills;
- Problem-solving skills;
- Presentation or 'influencing' skills: presenting and 'selling' your idea;
- Teamwork and collaboration skills;
- Multitasking;
- Learning skills, 'learning to learn';
- Flexibility;
- Communication skills: expressing oneself well both verbally and in written form;
- Foreign language skills;
- Cultural skills, cultural awareness;
- Leadership skills;
- Informal learning;
- Client-oriented mindset and business understanding; even for jobs that do not deal with clients directly;
- Contextual awareness: to have an understanding of factors that influence the steel sector.

According to Iskanius, Page and Anbu[293], the main types of skills required that are not yet fully available in the sector in Finland are:

- Marketing management skills;
- Customer-oriented mindset;
- Project management skills for international projects.

Flexibility and being able and ready to acquire new skills and knowledge throughout the course of one's career stand out as particularly important types of skills for the future. Only

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[291] Hanhijoki I. et al., on behalf of the Finnish National Board of Education, *Education, Training and Demand for Labour in Finland by 2025*, 2012

[292] The Finnish National Board of Education, *Requirements for Vocational Qualifications – Vocational qualification in Metalwork and Machinery 2020*, 2011

[293] Iskanius P., Page T., Anbu S.P., "The traditional industry sector in the changing business environment – a case study of the Finnish steel product industry", *International Journal of Electronic Customer Relationship Management,* vol. 4, no. 4, 2010, p. 402

an agile industry with staff that are able to adapt fast, learn new ways of working and "communicate effectively to take fast and well-informed decisions"[294] can effectively respond to changes in the market. As only fundamental knowledge can be imparted during the initial education, a steel sector worker should have awareness of their own potential knowledge gaps, so that they can fill these gaps during the course of their career, through lifelong learning.

Experts participating in the study also highlighted the growing need for staff with advanced digital skills that the current workforce does not satisfy, especially in relation to automation, data analysis and AI, as the industry becomes more reliant on complex machines and information systems.

As previously described, environmental sustainability is an increasing concern of the Finnish steel industry. It is therefore important for its workers, particularly the ones working upstream in the extraction of iron ore and other raw materials, to be aware of the concept of sustainability. More specifically, they have to be knowledgeable on raw materials and their geological context, modern mining techniques, material efficiency and recyclable materials, cutting waste as well as environmentally friendly working methods[295, 296].

There is a palpable mismatch between skills supply and demand in both blue-collar as well as white-collar profiles – the Finnish steel industry is encountering some difficulty in recruiting sufficient numbers of workers with relevant knowledge and skills. Nonetheless, national stakeholders involved in the study agree that the largest skills mismatch will in the near future materialise in blue-collar profiles as these will encounter a notable increase in skills requirements. For instance, while speaking Finnish was sufficient for such jobs before, English language skills will be more and more required as operations become increasingly global in nature. According to the representatives of the Finnish steel businesses, they already have difficulty filling blue-collar positions with local population and are therefore increasingly looking to hire migrants, which requires particular cultural considerations.

According to the participants in the Finnish National Workshop on Steel Sector Careers, Finland is a unique example of good practice in terms of cooperation between the industry and education providers in identifying skills needs and adjusting the curricula accordingly. In fact, historically, the relevant educational programmes were shaped in line with the needs of the steel industry. However, there is space for improvement in enhancing the collaboration of industry with educational organisations of different levels, apart from institutions in higher education, so that the skills gap in blue-collar profiles can be addressed.

In Finland, a number of institutions at different levels of government are involved in estimating current skills needs and anticipating future requirements. The objective of such estimates and forecasts is to translate findings into concrete policy measures, such as adjusting educational curricula and dedicated trainings.

At national level, these include[297]:

- **Ministry of Education and Culture** – Part of the PATKET consortium, which forecasts future labour demand for different business branches and the related long-term educational requirements.

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[294] Interview notes – Industry Stakeholders, Representative from the Association of Finnish Steel and Metal Producers

[295] The Ministry of Employment and the Economy, "*Finland's Mineral Strategy*", see: http://projects.gtk.fi/export/sites/projects/minerals_strategy/documents/FinlandsMineralsStrategy_2.pdf, Last visited 27.12.2019

[296] The Finnish National Board of Education, *Requirements for Vocational Qualifications – Vocational qualification in Metalwork and Machinery 2020*, 2011

[297] Berge, T., Berg, L. *Analysis, dialogue and dissemination of future skills needs – A study of three countries*, VOX, Norwegian Agency for Lifelong Learning, 2015

- **Ministry of Employment and the Economy** – Part of the PATKET consortium, active in the R&D of labour market information.
- **Finnish National Board of Education (FNBE)** – Analyses educational needs and supports the National Education and Training Committees. FNBE recently launched the National Project on Anticipation of Competences and Skills Needs (*Valtakunnallinen ammatillisten osaamistarpeiden ennakointiprojekti*).
- **National Education and Training Committees** – 26 sectoral committees set up by the FNBE to anticipate educational needs of respective sectors. These expert committees are tripartite, representing the employers' associations, trade unions as well as public authorities and education providers. They monitor and anticipate skills needs and develop proposals to adapt the curricula of upper secondary vocational education, continuous vocational as well as higher education.
- **Parliament Committee for the Future** – Responsible for selecting matters to be put on the agenda of the Government and the Parliament.
- **National Foresight Network (NFN)** – Consists of national stakeholders involved in foresight activities, provides a space to discuss and share information.
- **VATT Institute for Economic Research** – In charge of long-term economic analyses, makes employment forecasts for industries.
- **Employment and Economic Development Offices (TE Offices)** – Collect data on skills needs and provides results to companies, experts, governmental bodies and educational institutions. They focus on short-term skills needs, estimating "the demand for 200 occupations one year in the future".

In addition, the Finnish government has also launched a project to coordinate all national foresight stakeholders, which is led by the National Foresight Network and is coordinated by the Office of the Prime Minister and the Finnish Innovation Fund (Sitra).

At regional level, two types of bodies are tasked with the skills needs anticipation: Regional Councils as well as the Centres for Economic development, Transport and Environment (ELY Centres). Finally, at the local level municipalities run their own analyses and participate in local and regional workshops and forums.

The range and number of stakeholders involved in skills needs anticipation suggests that skills anticipation and development are strategic policy priorities for Finland and that significant resources have been allocated to this purpose. However, according to an independent evaluation[298] of the work performed by these bodies, shortcomings lie in, for instance, applying findings to design and implement effective policy measures. "*We got the impression that the problem is not the analyses of future skills needs; Finland has enough of these. The challenge is rather to make connections between the analyses and the decision-making processes*."[299] Moreover, the profusion of different analyses and of stakeholders involved in skills anticipation is also questioned: "*Especially because of the abundance of future analyses in Finland, it is worth questioning to what extent all the analyses actually are used… Besides, it may sometimes be hard to recruit a representative selection of persons in foresight groups, which may threaten the participation process*". The core objective of creating and implementing these skills anticipation tools is therefore not fully achieved.

These shortcomings are also echoed in a report published by the OECD[300]. According to them, more guidance should be given to the education sector on the basis of the findings from skills analyses and forecasts so that the curricula can be better aligned with skills needs. Moreover, the OECD recommends shifting resources in education from qualifications that are less in demand to the ones that are more so as well as ensuring that education

[298] *Ibid.*
[299] *Ibid., p. 43*
[300] OECD, *Back to Work Finland – Improving the re-employment prospects of displaced workers*, OECD Publishing, Paris, 2016

providers are able to respond more effectively to the rapidly changing skills needs. They also recommend improving the use of different skills anticipation tools for displaced workers (defined as people who have lost employment due to structural, economic or technical reasons). Namely, various skills and labour analyses and skills anticipation tools should provide relevant information to strategically design trainings to reskill unemployed people in line with labour demands.

Education and training

According to national stakeholders involved in the study, Finnish education and training systems are effective and marked by a high degree of quality.

In terms of higher education, cooperation between the industry and education providers is historically strong and represents an example of good practice in the EU, as mentioned above. They jointly implement a large number of activities that make up for a high-quality educational environment and also help students become aware of opportunities in the steel sector, namely:

- Curriculum planning in line with the industry needs;
- Mentoring (e.g. advising students what university courses to enrol in and which careers they can choose in the future);
- Visiting lectures by steel professionals;
- (Production) site visits;
- Apprenticeships, summer jobs and other forms of practical training in cooperation with the industry;
- Bachelor's, Master's and doctoral theses in collaboration with the industry, both in terms of funding as well as mentorship;
- Research projects.

Overall, while a significant number of activities are implemented in this area, access to these is often based on personal connections, according to the participants in the Finnish National Workshop on Steel Sector Careers, therefore there is a need for a more accessible, transparent and systematic approach.

A notable challenge is recruitment of new students. In the experience of national stakeholders involved in the study, educational programmes focussed too narrowly on steel often attract less students, possibly because of the sometimes-negative image of the sector, therefore offering a more general curriculum is often a better course of action for universities. National stakeholders reflect that making use of university students as ambassadors of higher education programmes in high schools could be a potential tactic to attract more students.

When it comes to Technical and Vocational Education and Training (TVET), the Finnish Metalwork and Machinery vocational education programme[301] offers three dedicated study programmes to prospective students: manufacturing technology, casting technology and automation technology and maintenance. These consist of a variety of modules, some of which are directly related to the technicalities of their future careers, while others are more general in nature. All three Metalwork and Machinery programmes share a number of modules that are compulsory for all vocational education students in Finland as well as some technical modules, such as Fundamentals of installation and automation. Students must also select several optional modules from a range of possibilities, such as cultural knowledge, entrepreneurship, information and communications technology etc.

Apprenticeships, as a form of on-the-job training, are commonly offered by the steel industry companies, particularly for work in mills. Apprenticeships combine formal learning in school with on-the-job training and apprentices are often offered employment in the

[301] The Finnish National Board of Education, *Requirements for Vocational Qualifications – Vocational qualification in Metalwork and Machinery 2020*, 2011

company where they complete their apprenticeship. According to national stakeholders involved in the study, apprenticeships are an effective way of guaranteeing a suitably trained new generation of workers.

Finland's Mineral Strategy[302] suggests improving education programmes by better combining environmental and mining technologies skills with skills in metal processing, machinery and equipment manufacturing. In this way, Finland would be better positioned to leverage new business opportunities and become an "innovative provider of technologies within the emerging green economy". The Strategy suggests shifting resources to develop training programmes for the following priority areas: invisible and intelligent mining, innovative processes, automation and optimisation, efficient use of materials, energy and water; minimisation of emissions; chemical/biological beneficiation processes; geodata systems and multi-dimension modelling; innovation exploration technologies; high-tech metal exploration and beneficiation; recycling new and alternative materials; environmental impact management and measurement". The Strategy also notes that it is imperative to ensure that the minerals sector is considered in the long-term educational planning, to promote the significance of metals, minerals and rock materials for everyday life as part of environmental educational at different educational levels and to increase resources for university training and research.

As potential avenues to further improve the educational environment in Finland, national stakeholders identify the following:

- Offering medium-length educational opportunities at all levels of education, as what is currently available is either a couple of days long training courses or several years long university programmes
- Better cooperation at all levels:
  - Among educational organisations at different levels of education
  - Between education providers of different levels and the industry
  - At the regional level by for instance establishing cooperation among universities and businesses in Finland and Sweden

To upgrade the skills of existing employees in the steel industry, ad hoc training courses are being set up locally in collaboration between the industry and vocational schools, often initiated by the industry itself, but also organised by the trade unions. For instance, an expert interviewed in the study explained that the trade union he is a part of organises trainings, that are available to all its members, on ICT and interpersonal skills, economics and on understanding the business model of their company. Another interviewed expert, who is part of a steel producers trade association, explained that all members of this association have agreements with local professional schools to provide trainings.

Another expert highlighted short training courses for the steel sector employees that are designed to tackle specific issues that have emerged in the sector. For instance, if a new technique has recently become important, a short seminar will provide an opportunity to provide workers with the basic knowledge. These trainings take the form of two-day seminars with a focus on one issue. For example, a dedicated seminar was set up on the specific material requirements for nuclear plants, when this type of operations started in the country. The topics of such trainings are selected by an Expert Committee that consists of a small group of relevant stakeholders, normally R&D directors and university professors, who are nominated by the national trade association of steel producers. Some seminars are organised on a recurring basis, for instance every five or six years, as they deal with general issues that remain important, such as trainings on refractory materials. Another example would be the effects of cold on different materials, which is highly relevant

[302] The Ministry of Employment and the Economy, "*Finland's Mineral Strategy*", see: http://projects.gtk.fi/export/sites/projects/minerals_strategy/documents/FinlandsMineralsStrategy_2.pdf, Last visited 27.12.2019

to certain parts of Finland, for instance to steel plants located in Oulu in the Northern part of the country.

Some of the trade union representatives involved in the study lamented the lack of practical tools to enhance the digital skills of the current workforce, particularly of blue-collar profiles. While individual programmes of about 300 people are being set up for this purpose, enhanced collaboration with TVET institutions is needed.

The image of the steel sector

According to numerous sources, steel sector is perceived rather negatively. According to several experts participating in the study, the unattractiveness of the of the Finnish metal industry, and more specifically steelmaking, may be its biggest problem, as it is likely to lead to shortages in the younger workforce in the upcoming years. In their SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis of the sector, Iskanius, Page and Anbu[303] list poor image of the sector as both a weakness and as a threat. The negative image of steelmaking is also corroborated by Finland's Minerals Strategy[304], which attributes the shortage of experts in the Finnish minerals sector precisely to its unfavourable image.

The participants in the Finnish National Workshop on Steel Sector Careers nuanced this picture by suggesting that the sector might be perceived differently by different stakeholder groups, such as potential employees, policy makers or the general public. As the main determinant of people's perception, the participants identified the knowledge of the sector. Namely, the image of the sector improves the more familiar with the sector one is, either in a professional sense (for example being a metallurgy student) or through personal connections (having friends or family members working in the sector). A related factor is also geographical proximity to a production site, as local inhabitants are naturally more familiar with the sector and in particular more aware of its economic importance for their community.

As positive aspects that make up the image of the steel sector, national stakeholders involved in the study identified that it is largely recognised as marked by high quality and in terms of its economic value, as a 'hero industry' and a backbone of the Finnish economy, particularly for the local communities where steel production sites operate. On the other hand, a number of aspects negatively affect the sector's image, for example that it is often considered traditional, rigid and old-fashioned, that its product is basic, unexciting and difficult to visualise or that the sector is polluting and energy intensive. Its economic volatility linked to global market conditions is also perceived negatively, exacerbated by reports of large layoffs in the media. Work conditions in the sector can also be viewed negatively, in that they entail a shift-based, rather monotone work in a male-dominated environment with potential health hazards. Finally, the Finnish steel sector's image suffers from the fact that production plants are often located in remote, sparsely populated areas of Northern Finland that many young adults are reluctant to relocate to.

Environmental sustainability is a major component of the overall image of the steel sector. According to national stakeholders involved in the study, the Finnish (and Nordic more generally) steel industry has made significant efforts to minimise its negative impact on the environment and boasts advanced technology for this purpose. It has now reached a point where its operations are relatively environmentally friendly, particularly in comparison to other countries with outdated technology and lower legal standards. The country could therefore potentially transfer this valuable know-how to the whole of the EU. Nonetheless, stakeholders lamented that these efforts are not sufficiently recognised outside the sector and are often compared to non-relevant contexts, also due to longstanding tradition of the steel sector within which any improvement is incremental and

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[303] *Ibid.*

[304] The Ministry of Employment and the Economy, "*Finland's Mineral Strategy*", see: http://projects.gtk.fi/export/sites/projects/minerals_strategy/documents/FinlandsMineralsStrategy_2.pdf, Last visited 27.12.2019

therefore might appear insignificant. In experience of some stakeholders, this negative image in relation to sustainability leads to difficulties in recruiting talent, particularly when it comes to young female professionals. Stakeholders also expressed concern that the narrative of the sector not being environmentally friendly might harm the industry in the region and ultimately lead to production being moved to locations with less sustainable practices. Therefore, there is an urgent need to promote sustainability actions better.

The issue at hand is that the sometimes less than ideal image of the sector can lead to difficulties in recruitment, particularly when it comes to students of fields outside metallurgy, for example of Information Technology, that are increasingly needed in the industry. The problem is likely to continue existing in the future and thus drive future workforce away from the sector, as students and young graduates may veer towards more appealing industries.

Since, as was previously stated, the rather negative image likely stems from the public not knowing the sector well enough and in particular young talents not being aware of the wide range of professional opportunities offered by the sector, the issue could potentially be addressed by awareness raising efforts. According to national stakeholders involved in the study, significant efforts are underway to improve the overall image of the sector, led mainly by the industry, in terms of research as well as subsequent communication campaigns. The latter target both students as potential employees, as well as the general public, and make use of a variety of communication channels, from traditional outdoor advertising to social media. In order to promote a positive image of the sector and thus attract new talent, direct contacts are also established mainly with metallurgy and other engineering students, already during their initial education and training, for example in the form of thesis support and company visits, among others, as further explained below.

As potential ways of improving the image of the steel sector, national stakeholders involved in the study propose:

- Promoting the relative sustainability of the Nordic steel sector
- Highlighting that the Finnish steel industry is knowledge-intensive and marked by a high degree of quality
- Reaching out to students at a younger age
- Targeting students of STEM (Science, Technology, Engineering, and Mathematics) as potential employees, as they represent a wider pool of potential talent but are at the same time more likely to have a potential interest in the steel sector
- Highlighting opportunities for professionals with different backgrounds, besides metallurgy, in the steel sector, particularly in relation to Information Technology, Artificial Intelligence, big data and environmental sciences
- Advertising good working conditions of the steel industry, particularly in terms of salary, and establishing production sites as clean and safe workplaces
- Fostering personal identification with the sector and pride in the profession

7.3.2. France

The steel industry and its competitiveness

France is currently the third largest crude steel producer in Europe after Germany and Italy[305]. Total production in 2018 reached around 15.4 million tonnes with a decrease of 0.7% compared to 2017 (about 15.5 million tonnes)[306]. Recent figures show that the production increased to 1,383 tonnes from 1,248 tonnes in a month (from February to March 2019). The average steel production in France from 1969 to 2019 is 1.6 million tonnes, reaching the highest production in January 1974 with 2,466 million tonnes and the lowest in December 2008 with 643,000 tonnes[307].

For the whole of 2017 and the first half of 2018, the French steel and metals sector[308] has seen an increase in sales prices together with an increase in demand, mainly in the automotive and construction sectors. An average increase in revenues of 2-3% was recorded together with an improvement in the operating margins of the companies. However, this benefit did not substantially affect the steel and metallurgical companies with a prevalent production towards the oil and gas industry (i.e. production of special steels for pipelines).

Due to the limited exports of the French steel and metals to the US (4% of the US market), the US import tariffs did not significantly impact this industrial sector[309].

Despite this, in the second half of 2018 the situation for steel and metallurgical French companies began to deteriorate due to factors such as the contraction of the construction sector, greater competitiveness, and excess global supply[310].

Regarding steel exports[311], France was the world's 12th largest steel exporter in 2017 with 14.7 million tonnes, which accounted for about 3% of global steel exports. In 2018, French exports decreased by 3% and reached 14.2 million tonnes. This export volume was equivalent to less than half of Japan's export volume, which is world's second largest exporter, and approximately one-fifth of the largest exporter, China. Steel represented just 2.5% of the total amount of goods France exported in 2018 (in terms of value).

The French steel industry is currently composed of:

- Three iron ore route production sites: Dunkirk, Fos-sur-Mer and Florange. In particular, the blast furnaces, the agglomeration and the steel mill in Florange are mothballed since 2012 due to weak demand
- Twelve electrical steelmaking plants distributed throughout the territory producing semi-products, excluding foundries and forges
- A number of plants dedicated to the first transformation (i.e. giving a first form to steels, like welded tubes, cut and dimensioned blanks, profiles of all shapes, cold drawns)[312]

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[305] EUROFER, "Crude steel production, all qualities", See: http://www.eurofer.org/Facts%26Figures/Crude%20Steel%20Production/All%20Qualities.fhtml, Last visited on 14.06.2019
[306] World Steel, "World Crude Steel Production - Summary", 15.01.2019, See: https://www.worldsteel.org/en/dam/jcr:dcd93336-2756-486e-aa7f-64f6be8e6b1e/2018%2520global%2520crude%2520steel%2520production.pdf, Last visited on 14.06.2019
[307] Trading Economics, "France Steel Production", See: https://tradingeconomics.com/france/steel-production, Last visited on 14.06.2019
[308] Altadius, "Market Monitor Steel Metals France 2018", See: https://atradius.it/pubblicazioni/market-monitor-steel-metals-france-2018.html, Last visited on 14.06.2019
[309] *Ibid.*
[310] *Ibid.*
[311] International Trade Administration, *Global Steel Trade Monito - Steel Exports Report: France,* 2019
[312] Syndex, *Fiche Pays - France*, May 2018, Data provided by Syndex (https://www.syndex.eu/)

The French steel market is dominated by ArcelorMittal, which is present in all business segments – Flat Carbon Europe (FCE), Long Carbon Europe (LCE), Downstream Solutions (processing semi-products up to final products) – and is particularly active in the automotive market outlets.

The other groups located in France focus production on:

- Long products (Riva Acciai)
- Stainless steel (Aperam, also owned by the Mittal family)
- Seamless tubes (Vallourec)
- Special long steels except for rails (Schmolz & Bickenbach Group)

In terms of R&D strategic assets of the French steel industry, one of the most notable examples is the ArcelorMittal Research Centre located in Maizières (Lorraine region). This research centre is 1 of 10 ArcelorMittal Centres in the world, and is focused on process and technical assistance, bars, rods and wires products[313]. With its capacity of around 500 researchers, it is one of the largest research centres in Europe.

Another centre (MetaFensch) was created in 2014 by the French government[314]. It is a steel and metallurgy platform carrying out R&D activities for rapid industrialisation of results. This platform is financed by the Future Investments Program (PIA) with a budget of EUR 20 million and is based in Uckange. It defines and carries out collaborative research projects, aiming at tackling the technological barriers for industrial projects all over France. The centre has experienced staff as well as experimental resources on a semi-industrial scale for the elaboration of metals.

20 years ago, most investments in research for the development of new steel types took place in Europe. Currently, European research cannot match the investment being made by Asian countries. Most of the industrial investments in Europe are focused on process research, i.e. CO_2 emissions reduction, more than the product itself. Although the real value for customers is the investment over the long term, public authorities do not follow R&D recommendations.

Financial and economic crises[315] have severely affected the French steel industry. The closures of Gandrange by ArcelorMittal (2008), two steel mills in Cheylas (2005) and more recently in Dunkirk (2016) by the Ascométal group (specialised in long products special steels) had a strong negative impact on the steelmaking area of Florange. Furthermore, Schmolz & Bickenbach (who bought Ascométal in early 2018) plan to close the Hagondange steel factory in two years.

Other steel plants affected by closures and restructuring were:

- Vallourec Group - the tube mills of Deville and St Saulve in 2016-2017 and that of Tarbes currently struggling for its survival
- NLMK Beautor - electrogalvanised sheet production in 2016
- Europipe in Dunkirk - large tubes production in 2016
- Bourbourg's tréfileries (Bekaert group) - galvanised wire production in 2014

In contrast, producers and manufacturers of stainless steels and high-speed steels (such as Aperam, Ugitech and Eramet) were more resistant to the crisis, due to the continuous

[313] See: https://corporate.arcelormittal.com/what-we-do/research-and-development/research-centres, Last visited on 14.06.2019
[314] See: http://www.metafensch.fr/fr/introduction.html, Last visited on 14.06.2019
[315] *Ibid.*

market requests. The same occurred to the Riva Acciai group's concrete wire factories in lower value-added products.

These restructurings led to direct and indirect job cuts, and the industry was targeted by several support measures from national public authorities. In addition to supporting Vallourec against the drop in orders in the oil and gas market, the French Government made a commitment in favour of the continuity of Ascoval's operation to save the workforce (270 employees). In 2019, the steel plant located in Saint-Saulve (Hauts-de-France) was taken over by British Steel[316]. The recovery of the French steel industry, confirmed in 2018 and 2019[317], is mainly due to the impact of ArcelorMittal's acquisition of ILVA in Southern Italy, which was complemented by the recovery of Ascométal and the Ascoval steel mill in St Saulve.

In 2017, the overall performance of the French steel industry was positive, a result in line with the rest of the European iron and steel industry[318]. The industry experienced an increase in its overall turnover, fuelled by a 5% increase in car sales and a 3% consumption increase in the construction sector. Anti-dumping measures on Chinese imports (which affected a wide range of flat carbon products and lead to a significant increase of raw material prices in the first half of 2017) also had a positive effect.

Despite the confirmed and expected growth fuelled by higher production in key downstream industries such as construction and automotive, the French steel industry still faces several challenges, which include[319]:

- Recovering investment levels, which experienced a significant slowdown since 2008
- Continuing to pursue R&D efforts
- Supporting research in new low-carbon and energy-efficient production models
- Internalising new management processes enabled by digitalisation
- Implementation of the new qualifications required for workers

Currently, the price of steel on the European market is the lowest in the world which makes Europe a target for dumping. The safeguards in place do not sufficiently protect the sector which is experiencing little growth. In addition, there is a complicated situation regarding CO_2 emissions: if the price of reserves becomes more and more expensive as well as the cost of production, steel production in Europe will lose its value. In this contest, the issue of raw material is also important: the price of this has decreased in recent years. In order to take advantage of such trends and for the steel industry to flourish, the car industry must be aligned and not look for steel elsewhere. Europe has a competitive niche in the steel sector (for certain types of metals, a certain standard of quality etc.) and thus should compare itself rather to other niche, high quality producers in South Korea rather than comparing itself with China that focuses on a different market segment.

Current and future skills needs

The French steel industry operates in an extremely competitive landscape. Innovation and continuous research play a key role in allowing French companies to maintain its position in the market. At the same time, the digital and technological transformation is having an increasing impact on tasks, required skills and work organisation. In the French steel sector, one of the main issues to be addressed is the new qualifications required to face the technological challenges linked to digitalisation and sustainability.

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[316] See: https://www.tellerreport.com/news/--france--ascoval-steel-plant-taken-over-by-british-steel-.HJQpC9PdiN.html, Last visited on 14.06.2019
[317] See: https://tradingeconomics.com/france/steel-production , Last visited on 14.06.2019
[318] Syndex, *Fiche Pays - France*, May 2018, Data provided by Syndex (https://www.syndex.eu/)
[319] EUROFER, *European Steel in Figures 2018*, 2018

In this context, the steel industry faces:

- a mismatch between the needed and available workforce with profiles matching key positions in manufacturing and ICT sectors[320]
- ongoing economic changes that are leading to new HR policy challenges for the metallurgy industry, of which the steel industry is a part[321]

Concerning the first point, the identified mismatch affects a number of key occupations. The analysis highlights shortages (insufficient supply of workers) for ICT and engineering, which is expected to increase in the upcoming years. At the same time, available professional profiles are expected to integrate a substantial amount of new technical and cross-cutting skills. Shortages are also related to a lack of candidates with the appropriate higher and vocational education (e.g. welders and structural metal workers).

The second point focuses on the effects of the internal reorganisation of metallurgy companies on skills and competence needs, with particular regard to greater flexibility in productivity and reduced fragmentation of tasks. Flexible production implies creating a "hard core" of production skills complemented by a set of cross-cutting competencies, which is achieved by using different forms of flexible schemes, such as outsourcing, temporary internal redistribution of tasks, interim hires or employees' mobility. Consequently, the workforce is asked to develop multiple skills, as a varied skillset guarantees companies greater flexibility in their organisation by facilitating temporary and continuous mobility of employees (internally and externally). This development is also expected to simplify the management of absences, improve motivation, reduce the incidence of occupational diseases, and mitigate the risks related to the departure of employees with key know-how and experience.

These transformations impact the functions and skills required by employees at each level of the value chain, involving the main branches in the metallurgy industry: management, commercialisation, product development/innovation, production and production support.

The constant need for innovation in products and production processes has increased the importance of R&D departments in the sector. As a consequence, specific skills are required, including the ability to work in multidisciplinary fields, manage projects and collaborate in complex and loosely structured organisations.

In the steel sector today, soft skills are becoming more and more important. There is a tendency to consider soft skills as a future need, but they are already need now in a rapidly changing work environment within the sector. The steel sector has already been well automated for a while now and it is important to point out that not everything can be automized, for example, customer relations, human senses that can recognise certain noises, smells in the factory etc. In order to prepare for Industry 4.0 paradigm, answers to the following questions are needed: where, how, when?

The skills requirements outlined above are further confirmed in the annual report of ArcelorMittal[322] (the major steel producer in France), which identifies strategic areas where these skills will be applied, including lifecycle analysis, robotics, data analysis, nanotechnologies, circular economy and 3D metallurgy.
The skills required for an increasingly digitalised industry need to be supported by the ability to adapt to change, exploit new technologies and thrive in a complex workplace. Industry 4.0 enabling technologies will transform manufacturing with higher yields at a lower social and environmental impact. Big Data platforms and AI algorithms are successfully used in vital areas such as defect recognition and quality assurance; deep

[320] Cedefop, "France: Mismatch priority occupations", See: https://skillspanorama.cedefop.europa.eu/en/analytical_highlights/france-mismatch-priority-occupations, Last visited on 05.06.2019
[321] L'Observatoire de la Métallugie, *Etude prospective sur l'évolution des emplois et des métiers de la métallurgie*, 2012, pp. 50-52
[322] ArcelorMittal, *Integrated Annual Review 2018"*, 2019, pp. 32-35

learning technologies can also enable predictive maintenance, and artificial vision combined with analytics improves safety and monitors environmental impacts at production sites.

The same skills needs are also presented in the Roadmap of the ESTEP Working Group Integrated Intelligent Manufacturing (I2M)[323], which includes representatives from the French steel industry. According to the workforce vision in the Roadmap, steel careers are driven by attitude to flexibility, job rotation and job relocation. In this context, the educational aspects need strict cooperation between private and public entities, including regional and state authorities.

Interviews with steel industry managers confirm the mismatches and skills needs related to digitalisation in the next years with particular focus on AI technologies. However, since these skills are highly sought after by the manufacturing industry, the problem of attractive salaries has to be considered. Difficulties in finding engineers, in particular metallurgical engineers, also come up in the interviews. The shortage for these professional profiles is mainly due to the Universities in France that unlike China, US, and other European countries, are no longer providing steel-related degrees. Only PhD students have a study career related to the steel sector and they are generally employed in R&D departments.

Finally, in order to better address the needs of the steel sector, a cross-cutting policy approach is needed (to attract more women to these jobs from elsewhere etc). Although there are a lot of studies carried out in France on the evolution of the sector and associated needs which are updated regularly, a system that identifies and evaluates skill needs is also necessary, Moreover, it is important to consider some aspects such as skill transfers and temporary work. Skill transfers inside a company should work in both directions: from the older employees to younger employees and the other way around. There is a common consensus that this stage has not yet been reached in France. The importance of temporary work should not be underestimated, because temporary work contracts can act as a trial period and any risks are external to the company.

Education and training

HE and VET systems are the main providers of education for the French steel industry. However, the experts in the interviews clearly state that what is provided does not correspond to the training needs of the steel industry and the other industrial sectors. In particular, universities in France are not structured to prepare metallurgical engineers, unlike other European countries, China and the US[324].

The need for more investment in training is not different in France compared to elsewhere in Europe. There is a strong need for further education, but this is something that can be resolved at national level. For example, dual education systems must be ramped up as the current rate of employment after this type of education is not high. Nowadays, companies employ only a maximum of 2-3% of employees from dual education systems. There should be a better cooperation between education and industry. Moreover, educational programmes in businesses should be made available at all employee levels. For jobseekers today, security and diversity of tasks are the most important elements even if work conditions can sometimes be difficult in the sector. This depends on the type of employee and the career aspiration but explains the need for educational programmes.

The Integrated Annual Review 2018 of ArcelorMittal[325] highlights the HE requirements for the French steel industry. The document underlines the need for graduates from scientific and technical disciplines, i.e. STEM. In addition, the university curricula should then be integrated with targeted training programmes designed by the steel industry. Finally, partnerships between educational systems (HE and VET) and steel industry should be encouraged. Such partnerships should aim at decreasing the training period and directly

[323] Roadmap "Integrated Intelligent Manufacturing", ESTEP Working Group(I2M) of ESTEP, 2016 pp. 19-20
[324] Interview notes - Industry Stakeholders, Former senior representative at ESTEP
[325] ArcelorMittal, 2019, op. cit., pp. 32-35

involve the employees in the work force as fast as possible. On this matter, ArcelorMittal supports the "*Prix des Innovateurs*"[326], which rewards young entrepreneurs or researchers with innovative projects. The latest theme of this innovator award, the Connected Factory, focuses on all the related areas of the steel industry such as maintenance, production, logistics, R&D, but also security, communication, purchases, HR, etc.

ArcelorMittal's Integrated Annual Review 2018 specifically mentions the growing presence of women in the industry in general (including the iron and steel industry), who are historically underrepresented especially in STEM professions. Specific actions to recruit and retain talented women need to be supported also for leadership positions[327].

To promote and support the transformation of the workforce, the theme of close cooperation between social bodies and industry constitutes a fundamental part of the Roadmap of ESTEP Working Group Integrated Intelligent Manufacturing (I2M)[328]. Considering that steel careers are driven by flexibility, job rotation and job relocation, students need an extended multidisciplinary background in scientific disciplines as well as digital systems.

Finally, large companies such as the ArcelorMittal University tend to promote steel careers at a national level with their own career study programmes and initiatives. They can thus ensure that promising candidates and workers keep improving their personal and professional skills.[329].

To overcome the shortage of some professional profiles in manufacturing and ICT sectors, several marketing campaigns are being carried out to increase interest in the industry. They target a wide group of young people, jobseekers and women who are under-represented in engineering occupations[330].These campaigns are carried out on a national scale, or locally by professional federations/trade unions supported by public agencies such as "*La semaine de l'industrie*"[331]and the exhibition "*Infinités Plurielles"*[332]. Since 2011, "*La semaine de l'industrie"* has been promoting the industry and its stakeholders by offering educational and discovery events to the general public such as company visits, job dating, career forums, web-conferences, classroom interventions, exhibitions. The main goals of these events are to enhance the attractiveness of the industry and its jobs, to make young people aware of industry jobs, and in particular the industry of the future, to inform the general public of the recruitment needs of the industry as well as to promote the image of a modern, innovative and ecological industry. Commissioned by the Ministry of Higher Education of Research and Innovation, the exhibition "*Infinités Plurielles"* is disseminating the scientific works performed by young researchers and professors to attract the interest of students, especially women. Additional initiatives are devoted to increasing cooperation between high schools/universities and companies through grants to support HE studies in the industrial sector.

At national level, the cross-cutting "Industrie du Futur" (Industry of the Future (IdF))[333] programme was launched by the French government in April 2015. It aims to support companies from different industrial sectors, steel included, to deploy digital technologies, to transform companies and business models as well as to modernise production practices. The funding model behind IdF combines private and public funding, i.e. all IdF's public

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[326] See: https://france.arcelormittal.com/le-prix-des-innovateurs.aspx, Last visited on 05.06.2019
[327] ArcelorMittal, *Integrated Annual Review 2018"*, 2019
[328] Peters, H., et al., *Roadmap of Integrated Intelligent Manufacturing in Steel Industry*, 2016 pp. 19-20
[329] See: https://corporate.arcelormittal.com/people-and-careers/working-at-arcelormittal/arcelormittal-university, Last visited on 05.06.2019
[330] See:https://skillspanorama.cedefop.europa.eu/en/analytical_highlights/france-mismatch-priority-occupations, Last visited on 05.06.2019
[331] See: https://www.semaine-industrie.gouv.fr/la-semaine-de-industrie-qu%27est-que-c%27est
[332] See: http://www.enseignementsup-recherche.gouv.fr/cid74249/infinites-plurielles-140-scientifiques-vous-parlent-de-science.html#album, Last visited on 05.06.2019
[333] European Commission, *France: Industrie du Futur*, 2017

financing tools are conditioned on private co-financing, and are deployed to encourage private investments in production areas, R&D, etc.

Another important initiative at the national level is related to a reform of VET that started in May 2018[334]. The reform includes a stronger engagement of social partners in shaping the content of VET curricula and an expansion of apprenticeships to all vocational high schools, which alternate periods of classroom-based learning with in-company training. The reform affects one-third of upper-secondary students and aims to improve the match between skills supply and demand and raise the prestige of VET as a road to excellence, facilitating transition to work. The push towards aligning the VET system with the labour market needs is based on the recommendations from a recent report commissioned by the Ministry of Education[335].

The French steel industry can benefit from the European Structural Investments (ESI) programmes mainly for SMEs growth, jobs opportunities as well as training on technologies for low-carbon production. In fact, through several national, interregional and regional programmes[336], France has been allocated EUR 26.73 billion from ESI funds over the period 2014-2020.

The national contribution, amounting to EUR 9.04 billion, is added to the European funds for a total budget of EUR 45.77 billion[337]. This amount is intended for investments in various sectors aimed at jobs creation, speeding up the transition to a low-carbon economy, supporting the competitiveness of SMEs, and finally, encouraging R&D activities for technological innovation.

The image the steel sector

France, after Germany and Italy, is the third country in terms of number of steel workers in the EU, with a total of 21,800 employees (2017 figures)[338]. The crisis and the linked restructuring operations have considerably weakened the steel industry's image in the national labour market. Despite the good economic prospects for the French steel industry, data from the Institut National de la Statistique et des Études Économiques (INSEE) show how job insecurity and unemployment are still affecting the reputation of the industry[339].

Moreover, problems of dumping, a high mortality rate often shown in the media and a perception of dirty buildings etc. are often associated with the steel industry. This negative perception is usually held by those that do not work in steel plants, therefore the industry must improve their communication especially towards local populations in order to change this negative association and to increase visibility among local politicians about the job advantages and opportunities that the sector offers. Regarding the negative perception on sustainability in the sector, it is important to emphasise that steel has already been recycled countless times. Public communication campaigns, like the one in the 2000s called « Made in Steel », could help to turn around this negative perception.

Although national experts interviewed in this study recognised that the French steel industry is making substantial efforts to improve its image through targeted initiatives and large-scale social media campaigns, they admit that the image of the steel sector in France is not very good. This goes especially for young adults with a university degree, who are more attracted by downstream industries, i.e. automotive, mechanical, aerospace, etc. The

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[334] Cedefop, "France : new VET reform launched" http://www.cedefop.europa.eu/en/news-and-press/news/france-new-vet-reform-launched, last visited 05.06.2019
[335] Ministère de l'Education Nationale, *La voie professionnelle scolaire - Viser l'excellence*, 2018
[336] European Structural and Investment Funds: Country Factsheets - France, https://ec.europa.eu/regional_policy/en/information/publications/factsheets/2016/european-structural-and-investment-funds-country-factsheet-france, Last visited on 04.06.2019
[337] *Ibid.*
[338] See: https://www.statista.com/statistics/640341/steel-industry-employment-european-countries/, Last visited on 14.06.2019
[339] Syndex, 2018, op. cit.

steel industry is often associated with an unwelcoming work environment, characterised by noise, pollution and a lack of safety[340].

The most relevant initiatives undertaken by French steelmakers include:

- Participation in scientific fairs, including the "Sciences de l'Ingénieur au Féminin" (the fourth and fifth editions were attended by ArcelorMittal Dunkerque) or the "Olympiades des Sciences de l'Ingénieur", attended by ArcelorMittal Montataire (see Table 8)
- Organisation of open door days to promote careers in steelmaking, such as those organised each year by the "Femmes de steel" network (see Table 8)

To make careers in steel more attractive, an interviewee from the Conseil National de l'Industrie suggested that communication efforts need to highlight the role of steelmaking in the technological, digital and environmental transformation of French manufacturing. In addition, the key role of R&D assets for the manufacturing of innovative products such as ultra-light steels for automotive need to be highlighted[341]. Another interviewee from a national metalworkers' union pointed out that communication alone is not enough, there is a need for employers to take concrete steps to improve the overall quality of work life, touching upon salaries as well as social and safety guarantees[342].

[340] Interview notes - Industry Stakeholders, Senior Manager at ArcelorMittal
[341] Interview notes - Public Authorities/Workers' Organisation, Representative from a management trade union, member of the Conseil national de l'industrie
[342] Interview notes - Workers' Organisation, Senior representative at FO Métaux - Fédération FO de la métallurgie

7.3.3. Germany

The steel industry and its competitiveness

In the course of industrialisation, German steel production found its first peak with an increase of crude steel production from 1.4 million tonnes in 1870 to 16 million tonnes in 1913 – a development enabled by several innovations including coke (a derivative of coal) as a reductant and technological invention. The price of steel declined, and the area of its application expanded. A transfer of production to locations with lower production costs could be avoided as steel production was very capital- and not so much work-intensive[343].

After the Second World War, the German steel industry, together with the coal sector, became one of the major drivers of economic growth[344], leading to the so-called *Wirtschaftswunder* – economic miracle. After an all-time high of 54 million tonnes of crude steel having been produced in 1974, a 10-year-crisis hit the German steel industry. In the 1990s, the sector witnessed a series of mergers, starting with the takeover of Hoesch AG by Friedrich Krupp AG in 1991, followed by the merger of Krupp and Thyssen in 1997[345]. International mergers and takeovers have since become an international trend with an average increase of 17% in firm takeovers and mergers from 1996 to 2014.

Today, the German steel industry is no longer focused on mass outputs but on more specialised and high-tech products. In 2012, high-quality steel represented more than 50% of Germany's total production. In the same year, German steel enterprises invested EUR 300 million in research – more than all their European competitors together. Every year 4,000 patents are registered, more than twice the registrations recorded 20 years ago, and more than half of the current 2,500 steel types were developed in the last 5 years[346].

In 2017, with a production output of 43.3 million tonnes of crude steel, Germany was the largest European steel producer and seventh largest steel producer in the world[347]. While the amount of produced steel remained roughly the same from the 1980s, and the amount of rolled steel produced even grew, the number of workers the sector employs decreased significantly, namely from 288,000 workers in 1980 to 85,000 in 2016[348]. Generally speaking, employment in the German industry is expected to decline by 0.2% per year in the period of 2021 till 2030[349]. Most of jobs will become available due to regular replacement cycles and will not represent newly created jobs[350].

Nonetheless, Germany is also facing a significant demographic change. While in the 1960s birth rates reached values of up to about 2.5, a decline began in the 1970s and reached its low point in 1994 with a birth rate of 1.24[351]. Although the number has now risen slightly to 1.57 in 2017[352], the German economy faces recruiting problems related to this change. The generations with high birth rates will soon retire, whereas the number of new young professionals is declining. In 2009, 893,561 students completed their education, while

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[343] Önder, F., *Fusions- und Übernahmekandidaten in der deutschen* Stahlindustrie, Springer Fachmedien Wiesbaden, 2016, p. 2
[344] Butzin, B., Pahs, R., & Prey, G., "Regionalkundliches Informationssystem des RVR zum Ruhrgebiet", 2009 See: http://www.ruhrgebiet-regionalkunde.de/html/ris_index.php.html, Last visited on 05.06.2019
[345] Önder, F., 2016, op. cit., p. 2
[346] Bein, H.-W, *Stahlmarkt in ständigem Wandel: Wie sich die Lage der Branche in den letzten 65 Jahren verändert hat*. Stahlmarkt. (7), 2016, pp. 12–13
[347] World Steel, *Steel Statistical Yearbook 2018*, 2018
[348] Wirtschaftsvereinigung Stahl, *Fakten zur Stahlindustrie in Deutschland 2017*, 2017
[349] Cedefop, *2018 skills forecast – Germany*, 2019
[350] *Ibid.*, p. 4
[351] Bundesinstitut für Bevölkerungsforschung. Zusammengefasste Geburtenziffer 1950-2015, See: http://www.demografie-portal.de/SharedDocs/Informieren/DE/ZahlenFakten/Zusammengefasste_Geburtenziffer.html, Last visited on 05.06.2019
[352] Statistisches Bundesamt. Zusammengefasste Geburtenziffer nach Kalenderjahren, See: https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bevoelkerung/Geburten/Tabellen/geburtenziffer.html, Last visited on 05.06.2019

831,812 did so in 2017 – a decline of about 7%[353]. Consequently, the German apprenticeships market already faces shortages of young professionals. For instance, in 2017/2018, only 535,623 applicants registered for 565,342 apprenticeships that were offered[354]. According to some of the HR representatives of German steel companies, there are currently enough apprentices to fill the vacant jobs, but the number of candidates and their qualification and skill levels are gradually decreasing.

The effects of this demographic change are particularly problematic in the steel industry[355,356]. In many companies, older employees are disproportionally represented[357]. For instance, in 2006, 31.3% of workers and 37.1% of employees in the German steel industry were older than 50 years, while in the overall economy only 22.7% of workers and 21.2% of employees were above 50. Recruitment of engineers and professionals from other STEM disciplines is particularly difficult[358]. In October 2018, nearly 500,000 STEM jobs were vacant, while only 160,000 STEM related unemployed individuals were looking for a job[359].

Meanwhile, foreign STEM employees have increasingly become a hiring pool to solve recruitment problems in the German labour market. Between 2012 and 2018, the number of foreign STEM professionals increased from 303,000 to 420,000 and the number of foreign STEM academics grew from 69,600 to 119,900. Additionally, with the increase of immigration numbers, the training of refugees has also commenced in an effort to fight the shortages. At the beginning of 2018, there were 19,200 STEM employees from Afghanistan, Eritrea, Iraq, and Syria compared to as little as 2,700 in 2012[360].

Employees in the steel sector are often unionised in IG Metall. Founded in 1949, it is the country's largest trade union with 2.27 million members at the end of 2018[361]. Despite its name, IG Metall today unites workers from various industrial sectors, including the textile and wood industry[362]. Early in the history of the Federal Republic of Germany, improvements in labour rights were achieved. In 1951, the Coal and steel co-determination law (*Montan-Mitbestimmungsgesetz*) was passed by the German parliament, requiring larger enterprises from the coal and steel industries to staff their supervisory boards with employees and shareholders in an equal manner[363]. According to IG Metall, the union's gains include also for instance the introduction of the 5-day work week in 1956 and the introduction of the 35-hour work week in 1984[364].

The German steel sector, that for the most part plays the role of a supplier to other industries, is therefore hugely important for the overall economy. Its employment multiplier is 2.3, indicating that one job in the steel sector supports 1.3 jobs at suppliers or service companies. Similarly, the Germany steel sector features large demand effects:

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[353] Statistisches Bundesamt, *Bildung und Kultur: Allgemeinbildende Schulen - Schuljahr 2017/2018*, 2018

[354] Bundesagentur für Arbeit, "Ausbildungsstellenmarkt: Die aktuellen Entwicklungen im Berichtsjahr 2017/2018 in Kürze". See: https://statistik.arbeitsagentur.de/Navigation/Statistik/Statistik-nach-Themen/Ausbildungsstellenmarkt/Ausbildungsstellenmarkt-Nav.html, Last visited 05.06.2019

[355] Acemyan-Steffens, T. V., & Neuhäuser, M., *Aktuelle Wege und Trends der Personalentwicklung, Rekrutierung und Nachfolgeplanung (Arbeitspapier No. 230)*, Hans-Böckler-Stiftung, Düsseldorf 2011

[356] Szymanski, H., & Lange, A., *Den demografischen Wandel in der Eisen- und Stahlindustrie gestalten: Eine Handlungshilfe zur alter(n)sgerechten Arbeitsgestaltung*, 2014

[357] Szymanski, H., & Lange, A., *Den demografischen Wandel in der Eisen- und Stahlindustrie gestalten: Eine Handlungshilfe zur alter(n)sgerechten Arbeitsgestaltung*, 2014, p. 13

[358] Acemyan-Steffens, T. V., & Neuhäuser, M., 2011, op.cit., p.13

[359] Iwd, "Die MINT-Lücke wird größer", 26.11.2018, See: https://www.iwd.de/artikel/die-mint-luecke-wird-groesser-411427/, Last visited on 05.06.2019

[360] *Ibid.*

[361] IG Metall, "IG Metall wächst und packt Zukunftsfragen entschlossen an", See: https://www.igmetall.de/presse/pressemitteilungen/ig-metall-waechst-und-packt-zukunftsfragen-entschlossen-an, Last visited on 05.06.2019

[362] IG Metall, "Unsere Geschichte: Die IG Metall vom Kaiserreich bis heute" See: https://www.igmetall.de/ueber-uns/geschichte/die-geschichte-der-ig-metall, Last visited on 05.06.2019

[363] Spickenbom, I., *Mitarbeiterbeteiligung und Unternehmensentwicklung: Neue arbeitsorganisatorische Ansätze in der deutschen Stahlindustrie dargestellt am Beispiel Thyssenkrupp Stahl*, Biefeld University, Bielefeld, 2003

[364] IG Metall, "Unsere Geschichte: Die IG Metall vom Kaiserreich bis heute" See: https://www.igmetall.de/ueber-uns/geschichte/die-geschichte-der-ig-metall, Last visited on 05.06.2019

EUR 1 demand for steel leads to further demands of EUR 1.73 in its upstream industries. The resulting production value multiplier of 2.73 is the highest multiplier of all German industries[365].

According to national stakeholders involved in the study, it is of utmost importance to increase the quality of steel and to compensate for the increased production costs for the German steel industry to remain competitive. Therefore, employing and retaining top talent is crucial, which is sometimes hampered by the image of the sector.

Other major challenges include:

- Over production in other regions of the world;
- Trade restrictions;
- Mergers;
- Labour costs;
- CO_2 limits, emissions trading and environmental sustainability issues in general.

The German steel industry has made efforts toward environmentally sustainable production – it reduced CO2 emissions and increased raw materials efficiency[366]. While the metal industry remains one of the most important emitters of greenhouse gases in Germany[367] and the potential to further improve the sustainability of production exist, the industry emphasises that steel itself is a sustainable material[368]. The industry is therefore in favour of an environmental policy that considers both economic and social aspects of sustainability[369].

Current and future skills needs

The trends described above represent a threat to the German steel industry. As populous generations of older employees retire, fewer young professionals enter the labour market, especially those who are interested in the steel industry. Additional problem is a general preference for university studies and management positions as opposed to vocational education. The steel industry therefore has some difficulty filling more technical positions, particularly with middle-skill workers. On the other hand, some of the more recent high-skill profiles in the sector, such as for example computer scientists, are also difficult to hire, as they are not yet aware of the relevant opportunities within the steel sector, or might find other industries more attractive nonetheless.

In response to that, defining an adequate talent management strategy to attract and retain talented and motivated young people in today's so-called war for talents has become of utmost importance for strategic human resources development in the steel sector[370]. An employer's market from the past has now become an employee's market with workers increasingly determining where and how they want to work. Information on attitudes, needs and perceptions of highly skilled employees is also fundamental to shape adequate strategies. Companies have to offer attractive workplaces and working conditions and adjust to the labour market by for instance employing women, ensuring work-life-balance and implementing new leadership and knowledge management.

In an effort to draw interest to the steel sector and to foster STEM orientation among students, German steel companies are undertaking numerous activities. They are

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[365] Önder, F., *Fusions- und Übernahmekandidaten in der deutschen* Stahlindustrie, Springer Fachmedien Wiesbaden, 2016, p. 6

[366] Wirtschaftsvereinigung Stahl, *Stahl und Nachhaltigkeit: Eine Bestandaufnahme in Deutschland*, 2017, p.5

[367] Umweltbundesamt, "Emissionsquellen", 10.01.2016, See : https://www.umweltbundesamt.de/themen/klima-energie/klimaschutz-energiepolitik-in-deutschland/treibhausgas-emissionen/emissionsquellen, Last visited on 05.06.2019

[368] Wirtschaftsvereinigung Stahl, *Stahl und Nachhaltigkeit: Eine Bestandaufnahme in Deutschland*, 2017, p. 5

[369] Wirtschaftsvereinigung Stahl, "Die Nachhaltigkeit der deutschen Stahlindustrie", See: https://www.stahl-online.de/index.php/themen/energie-und-umwelt/nachhaltigkeit/, Last visited on 05.06.2019

[370] Acemyan-Steffens, T. V., & Neuhäuser, M., *Aktuelle Wege und Trends der Personalentwicklung, Rekrutierung und Nachfolgeplanung (Arbeitspapier No. 230)*, Hans-Böckler-Stiftung, Düsseldorf 2011

presenting their projects and career opportunities in kindergartens, primary, secondary, as well as vocational education institutions, mainly at the regional level of where a given company is placed. They are also intensifying their marketing efforts in universities, organising open days and participating in career fairs. Businesses also support students by providing them with scholarships or other forms of financial or ideational support. Relevant instruments are also the so-called dual study programmes that combine studies at institutions of higher education with on-the-job training[371].

In the future, occupational profiles may change significantly in response to Industry 4.0 developments, including in the sense of completely new occupational profiles arising[372]. Generally, there are two schools of thought regarding the interaction of humans with autonomous systems within Industry 4.0. One argues that workers will have to be trained to be able to integrate in the new production environments, whereas the other says that autonomous systems will reduce the amount of skilled workforce that is needed[373].

Possible requirements related to Industry 4.0 are not completely clear yet and will depend on specific contexts. However, generally speaking, the following types of skills will be increasingly important in the future: planning, organisation and evaluation of work, operational and technical communication, control techniques, and customer orientation[374,375]. Industry 4.0 companies will also expect their employees to possess advanced digital skills, for instance related to online communication, data input, processing and analysis, information research as well as conscious data transfer[376].

Education and training

Generally, young professionals can find their way into the German steel industry by studying or by doing an apprenticeship.

In terms of Technical and Vocational Education and Training (TVET), apprenticeships are organised within the framework of the famous German dual education system, combining theoretical learning from a vocational school with practical experience in a company, generally within a three-year long programme[377]. There are 17 apprenticeship programmes, 11 technical and 6 commercial ones, that are relevant for the steel sector[378]:

Table 23 — Apprenticeships within the German VET system

Technical training	Commercial training
Chemical laboratory technician	Office administrator
Electronics technician for automation technology	IT specialist
Electronics technician for industrial engineering	Industrial clerk
Industrial mechanic	IT clerk
Design technician	IT systems electronics technician
Mechatronics technician	Office communication clerk

[371] Acemyan-Steffens, T. V., & Neuhäuser, M., *Aktuelle Wege und Trends der Personalentwicklung, Rekrutierung und Nachfolgeplanung (Arbeitspapier No. 230)*, Hans-Böckler-Stiftung, Düsseldorf 2011
[372] Spöttl, G., Gorldt, C., Windelband, L., Grantz, T., & Richter, T., *Industrie 4.0: Auswirkungen auf Aus- und Weiterbildung in der M+E Industrie*, 2016, p. 111
[373] Ahrens, D., & Spöttl, G., "Industrie 4.0 und Herausforderungen für die Qualifizierung von Fachkräften", in H. Hirsch-Kreinsen, P. Ittermann, & J. Niehaus (Eds.), *Digitalisierung industrieller Arbeit: Die Vision Industrie 4.0 und ihre sozialen Herausforderungen*, pp. 185–204, Nomos edition sigma, Baden-Baden, 2015, p. 190
[374] *Ibid.*, p. 197-199
[375] Spöttl, G., Gorldt, C., Windelband, L., Grantz, T., & Richter, T., *Industrie 4.0: Auswirkungen auf Aus- und Weiterbildung in der M+E Industrie*, 2016, p. 103-104
[376] Stettes, O., *Qualifizierungsbedarf in Zeiten von Industrie 4.0: Workshop „Qualifizierung 4.0"*, Wirtschaftsvereinigung Stahl, Düsseldorf, 2019
[377] Cedefop, *Spotlight on VET Germany*, 2017
[378] Wirtschaftsvereinigung Stahl, "The steel industry – excellent employers and trainers" See: https://en.stahl-online.de/index.php/topics/career-and-training/jobs-and-studies/, Last visited on 05.06.2019

Technical training	Commercial training
IT systems electronics technician	
Process mechanic in the metallurgical and semi-finished products industries	
Materials tester	
Toolmaker	
Cutting machine mechanic	

About 4,620 apprentices are currently receiving vocational training in the German steel industry[379]. The share of apprentices out of the total number of employees in the sector was 5.2% in 2012[380]. According to national stakeholders involved in the study, apprenticeships and the dual education system in general are an effective way of solidifying theoretically acquired knowledge as well as providing junior staff with fundamental skills they need, such as planning and social skills and knowledge of Industry 4.0. Such a system also improves the quality of recruitment and leads to better integration of employees in their new companies. It is therefore important that it is further supported in the future and that its advantages and opportunities stemming from it are better promoted.

Notably and as an example of good practice, content on digitalisation and Industry 4.0 has recently been added to apprenticeships related to the steel sector, such as apprenticeships in plant and industrial mechanics[381,382]. Nonetheless, the content is focussed on the general concept of Industry 4.0 as well as its economic aspects, rather than on concrete tasks relevant for the wider workforce[383], which could be seen as a potential point for improvement. As other points for improvement of the vocational education system, national stakeholders suggest promoting performance-oriented training as well as allowing the apprentices that perform well the option of choosing a different position to the one that they are automatically offered when they complete the apprenticeship.

In terms of higher education, there are 17 different study programmes relevant to the steel sector[384]:

1. Metallurgy & material technology / material engineering
2. Mechanical engineering
3. Electrical engineering or electronics
4. Physics, chemistry, process technology
5. Industrial engineering with business studies
6. IT
7. Mathematics
8. Civil engineering
9. Production technology
10. Safety systems
11. Supply and disposal technology
12. Agricultural sciences
13. Geology
14. Industrial environmental protection
15. Infrastructure management
16. Medicine
17. Logistics

As ways to improve educational programmes and also help students become aware of opportunities in the steel sector, the participants in the German National Workshop on

[379] Wirtschaftsvereinigung Stahl, "The steel industry – excellent employers and trainers" See: https://en.stahl-online.de/index.php/topics/career-and-training/jobs-and-studies/, Last visited on 05.06.2019
[380] *Ibid.*
[381] Graupmann, U., *Qualifizierung 4.0: Qualifizierung durch Aus- und Weiterbildung in der Stahlindustrie*, 2019
[382] IG Metall, "Unsere Geschichte: Die IG Metall vom Kaiserreich bis heute", See: https://www.igmetall.de/ueber-uns/geschichte/die-geschichte-der-ig-metall, Last visited on 14.06.2019
[383] Spöttl, G., Gorldt, C., Windelband, L., Grantz, T., & Richter, T., Industrie 4.0: Auswirkungen auf Aus- und Weiterbildung in der M+E Industrie, 2016, p. 96
[384] Wirtschaftsvereinigung Stahl, "The steel industry – excellent employers and trainers" See: https://en.stahl-online.de/index.php/topics/career-and-training/jobs-and-studies/, Last visited on 05.06.2019

Steel Sector Careers suggested running research projects in collaboration with the industry as well as establishing trainee/alumni circles with regular meetings.

National stakeholders involved in the study also evaluate internships offered by the steel industry to university students as a good educational opportunity, particularly to potentially help attract underrepresented groups such as women. To further improve this method, they recommend increasing the duration of internships beyond a couple of weeks and making sure they entail mentorship.

In terms of upskilling and reskilling efforts for the existing workforce, public measures are mainly targeted towards smaller and medium enterprises, whereas larger companies are often responsible for such activities themselves. What kind of further educational opportunities exist and to what extent they are available to workers is therefore highly dependent on each specific company.

The participants in the German National Workshop on Steel Sector Careers were of the opinion that all the employees should continue developing their skillsets throughout the course of their lives, even though some of the older ones may sometimes be reluctant to do so. It is therefore of major importance to solidify upskilling and reskilling efforts. Further education and training are also important to increase employee satisfaction, foster loyalty to the company, and the sector, and ultimately decrease its employee turnover rate.

According to national stakeholders, businesses themselves should not only comply with the requirements of training regulations but become the central further education bodies by establishing in-house academies and providing certifications. They should promote lifelong learning and competence adaptations in response to changes in the market. It is also important that they take into account the demographic changes and focus on the transfer of knowledge and team-oriented work. The so-called reverse mentoring, which is already a part of further education, should be done in a more structured manner. In this way, older employees will be able to pass on their knowledge, whereas junior staff can in return help them with the more novel technological applications.

Other potential ways to improve in-company training, identified by national stakeholders, include:

- Cloud-based solutions (e.g. in maintenance) and working with virtual teams
- Videos and guidelines that, among other things, communicate the corporate culture to junior staff
- Specialised training and certification of trainers within companies (work pedagogy)

Furthermore, companies in the steel sector should join forces and work on these issues together in order to pool information on training needs as well as find new ways of implementing further education and training. They could also jointly engage in lobbying efforts to guarantee the needed supply of skills. Cooperation among companies could potentially also lead to attractive mobility opportunities for the workers.

On the other hand, according to national stakeholders, individuals should also take initiative for and ownership of their personal further education. They should engage in lifelong learning and adopt a holistic view of the steel sector in order to improve their skillset in line with labour market demand.

The image of the steel sector

According to the estimates of national stakeholders involved in the study, there is no unified perception of the steel industry at the national level due to lack of familiarity of the general public with the sector. This issue possibly stems from the fact that the steel industry does not produce one emblematic product and that its production processes are complex. People's perceptions are therefore often stronger when it comes to individual companies rather than the sector as a whole. In fact, stakeholders note that, despite efforts by individual companies, the steel sector as whole has up to now paid limited attention to

how it is perceived by the general public as it has, as a business-to-business industry, rather focussed on company to company communications. There is therefore significant potential for improvement on this front.

Where perceptions do exist, they tend to be rather negative. The public generally regards the industry as old-fashioned and associates it with the coal industry as well as with hard physical work in a dirty, noisy and hot environment. Such connotations related to the past are often reinforced by the media[385]. An important aspect is also a perceived lack of environmental sustainability of the sector, which is heavily criticised, despite steel production companies being for instance among the largest recycling companies in Germany and representing an example of good practice when it comes to circular economy.

More generally speaking, industry professions are quite negatively perceived and therefore unpopular in Germany. Particularly professions requiring vocational education tend to be dismissed in favour of university studies. Vocational education possibilities are often rather local in character whereas higher education is associated with a more varied spectrum of opportunities, as well as with a higher salary. In the opinion of the participants in the German National Workshop on Steel Sector Careers, such perceptions are often propagated by the parents and teachers of prospective students as well as career counsellors who do not have a good understanding of the variety of possibilities offered by vocational education.

In terms of messaging that should be conveyed to improve the image of the steel sector, the participants in the German National Workshop on Steel Sector Careers emphasized:

- Improving the image of vocational education in general, including highlighting the option of combining vocational education with university studies
- Showcasing how the society would look like without steel to create a powerful communication image
- Promoting the relative sustainability of the sector – Apart from highlighting innovative projects in the sector of substituting coal with hydrogen fuel or capturing CO_2 for the chemical industry, the focus of the conversation should be steered away from CO_2 emissions alone towards other aspects of sustainability, particularly in terms of the steel industry being an example of good practice when it comes to material efficiency and circular economy.
- Advertising new types of job profiles within the sector
- Highlighting how the sector can satisfy the demands of the younger workforce for work-life balance, stable employment and good salaries
- Stressing safe working conditions

As potential tactics to employ for this purpose, the participants proposed:

- Ambassadors – Employees could be ambassadors for the general public and trainees could play this role with their peers as they might be perceived as more trustworthy and authentic. Their stories could make the steel production tangible and concrete. Young people could also potentially use social media (e.g. Instagram) to talk positively about their experience with the industry.

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[385] Media tend to report on the challenges the industry faces and reinforce the negative perception using specific imagery that shows workers throwing coal in the furnace rather than portraying the modern side of the industry. As a few examples, see: Ulrich, K., "Der lange Weg zum grünen Stahl", *DW*, 26.07.2019, https://www.dw.com/de/der-lange-weg-zum-gr%C3%BCnen-stahl/a-49752965, Last visited on 09.05.2020;
"Stahlkartell muss 646 Millionen Euro Strafe zahlen", *Spiegel*, 12.12.2019, https://www.spiegel.de/wirtschaft/unternehmen/stahlkartell-muss-646-millionen-euro-strafe-wegen-preisabsprachen-zahlen-a-1300953.html, Last visited on 09.05.2020;
„Thyssenkrupp spaltet sich in zwei Unternehmen auf", *Zeit Online*, 27.09.2018, https://www.zeit.de/wirtschaft/unternehmen/2018-09/thyssenkrupp-spaltet-sich-in-zwei-unternehmen-auf, Last visited on 09.05.2020
Schröder, T., „Stahl bedeutet Stärke", *Zeit Online*¸29.03.2018, https://www.zeit.de/wirtschaft/unternehmen/2018-03/importzoll-stahlbranche-usa-donald-trump-protektionismus/komplettansicht, Last visited on 09.05.2020

- Open days – Steel plants opening their doors and showing the production process itself could be an effective way to establish contacts with families and promote transparency.
- Campaigns at regional level – This could serve as a way for steel companies to present how they support the region they are based in as well as how the industry has developed in the recent decades.
- Cooperation with the related industries – It might be more effective to join forces with other related industries, in order to address the common image problem of manufacturing industries.
- Lobbying, public relations and networking

7.3.4. Italy

The steel industry and its competitiveness

Italy is the second largest steel producer in the EU after Germany and the 10th largest steel producer worldwide. Italy is also one of the main consumers and importers of steel, due to its well-developed ecosystem of steel-intensive industries, such as automotive, mechanical engineering, construction and tube production. The production of domestic crude steel is estimated at 24.5 million tonnes in 2018, which marks an increase of 1.9% compared to the previous year. Specifically, Italy produced 16.9 million tonnes of carbon steels and 7.1 million tonnes of specialty steels, including 1.5 million tonnes of stainless steels. Italy has not yet recovered its production levels from before the financial crisis and the national economy has experienced a notable slowdown.

The analysis of hot production for 2018 highlights diverging trends between long and flat products: while the long products output, with a total of 12.4 million tonnes produced, marked an improvement compared to 2017 (+ 4.1%), the flat products output dropped to 11.2 million tonnes, a decrease of 1.6%. The commercial balance experienced a decrease of 2.2 million tonnes in produced volume, while registering an increase in value of EUR 2.3 billion. Revenues generated by steel production amounted to EUR 40 billion (+17% compared to 2017). Steelmaking's direct contribution to the Italian GDP was 0.3%, while the indirect contribution reached 10%.

Regarding the activity of steel downstream industries, 2018 was marked by a significant slowdown in the automotive sector, where production fell by 3.4% compared to the previous year. In line with the general macroeconomic trend, steel-intensive industries in Italy experienced a significant downturn[386].

In 2018, direct employment in the primary steel industry accounted for 33,500 positions, i.e. 1% less compared to the previous year. More generally, employment in the Italian steel industry (ATECO codes 24.1, 24.2 and 24.3[387]) is estimated at 33,356 jobs. The employment trend[388] in the Italian steel industry suffered an abrupt downward change in the aftermath of the 2008 financial crisis, which marked the beginning of a steady reduction in employment, which has not yet ended (halfway through 2019).

The steady reduction in employment is largely a result of:

- the substantial decrease in steel production;
- the closure of plants;
- plants producing below capacity (particularly the Taranto plant);
- the introduction of control and management systems and high levels of automation of production processes in the framework of Industry 4.0.

Historical perspective

At the end of the Second World War, new projects were needed to relaunch production. The main drivers of this new phase were:

- Reconstruction and new projects;
- The Sinigaglia Plan[389];

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[386] Federacciai 2019 Yearly Assembly Report

[387] See: https://www.codiceateco.it/divisione?q=24, Last visited on 15.05.2019

ATECO is an automatic coding system created by the Italian National Institute of Statistics (ISTAT) to classify economic activities.

[388] Federacciai 2019 Yearly Assembly Report

[389] Sinigaglia Plan" is the name given to the ambitious restructuring program of the Italian steel industry which takes its name from Oscar Sinigaglia, who developed it in 1933 as president of the Ilva steelworks. Approved by the Italian government in 1948, the plan was based on the expectation that post-war reconstruction would require large quantities of iron and steel and that it was therefore necessary to provide the country a competitive heavy. The core of the project was the plant of Genoa-Cornigliano (later named after Sinigaglia), in which the

- Italy's accession to the ECSC and the restructuring of the 1950s;
- The economic boom of the 1960s.

Immediately after the war, the control of Italian steel production was equally divided between the public sector (Finsider) and the private sector. Under the Sinigaglia plan, the Italian steel industry was relaunched by driving State investments in large coastal integrated steel plants such as Cornigliano, Piombino and Bagnoli. Additionally, the plan called for the construction at Cornigliano of a new continuous hot strip mill for wide flat products (coils), a new technology developed and implemented in the US, to support the growing demand of the Italian automotive industry.

Italy's membership to the ECSC favoured the strengthening and competitiveness of the Italian steel industry. Adhering to the ECSC brought Italy great advantages in terms of low raw materials costs, as well as investment aid and corporate restructuring funds. In 1962, for the first time ever, the prices of steel products in Italy were lower than the corresponding German prices.

In the period from 1956 to 1973, the three main Italian State-owned integrated steel plants (Genoa Cornigliano, Bagnoli and later Taranto) were incorporated in a new company, formed in 1961, called Italsider. At the same time, private steel producers such as Falck and Readelli experienced a gradual but steady decline. Fiat left steel production activities, passing its facilities to Finsider. In the meanwhile, the market of mini-mills started emerging, with the first mini-mills installed in the surroundings of Brescia, producing rods and rebars with EAFs and continuous casting[390].

The 20-year great expansion established Italy as one of the most prominent steel producing countries. The adhesion to the ECSC, together with the intense activity of the State-owned steel industry (led by Finsider), played a crucial role in modernising the country's industrial infrastructure and in lowering steel prices. The 1970s energy crisis, however, marked the beginning of Italsider's decline.

With the 1974 oil crisis, which marked the end of the great economic boom in the West, steel industries in Japan, Western Europe, and North America entered a protracted period of decline[391]. In spite of the crisis, the Italian steel market held up well compared to the rest of Europe, and the mid-1970s recession in Italy was a lot less severe than in other European countries. In line with this trend, Finsider's steel output grew steadily until 1974 and did not significantly fall thereafter, at least until the 1980s.[392] It should be noted that, by the early 1970s, Italy's public sector had already carried out major technological modernisations. Taranto, in particular, stood out as one of the most important centres of technological excellence in the country[393]. However, Finsider was increasingly affected by low capacity utilisation, and spiralling production costs. Finsider's labour productivity, for example, failed to show any progress between 1968 and 1980, despite a considerable amount of new investments.

Between 1980 and 1987, the EC industry's hot rolling capacity fell by 32 million tonnes (from 172 to 140 million tonnes). During those years, the Italian steel industry underwent a significant restructuring: production capacity dropped by 7.2 million tonnes, and approximately 69,000 workers were laid off. The crisis of Finsider marked the end of Italy's State-driven steel industry. The private sector managed to adapt to the consequences of

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integrated production-cycle was adopted (as in the factories of Piombino and Bagnoli). Thanks to the Sinigaglia plan, the national steel industry was revitalised, with production capacity rising from 3 to 9.2 million tonnes between 1938 and 1962.

[390] Balconi M., *La siderugia italiana (1945-1990) - Tra controllo pubblico e incentivi del mercato*, Fondazione Assi, Il Mulino, Bologna, 1991

[391] Vanderseypen G., "La politique de restructuration sidérurgique : Un bilan nuance", *Revue du Marché commun et de l'Union européenne*, n. 386, March 1995, p. 164

[392] Meny, Y. & Wright, V., *The Politics of Steel: Western Europe and the Steel Industry in the Crisis Years (1974-1984)*, Walter De Gruyte, Berlin, 1987.

[393] Balconi M, *La siderugia italiana (1945-1990) - Tra controllo pubblico e incentivi del mercato*, Fondazione Assi, Bologna, Il Mulino 1991

the steel crisis by concentrating production on fewer companies (e.g. Lucchini, Riva, Pasini, etc.) focusing on higher value-added products. While the mini-mill sector still dominated the long products market, production sites decreased by 44 units between 1976 and 1996 (going from 72 to 28)[394].

All over Europe, the steel industry underwent a progressive process of privatisation. Between 1986 and 1995, the share of privately-owned steelworks skyrocketed from 46% to 92%. Italy followed the same trend. Despite a final attempt to re-establish itself with the restructuring of the "New Italsider" into ILVA in 1989, publicly-owned steelmaking experienced a massive sell-off in 1993. By 1996, all State-owned steel companies were completely privatised[395].

- Ilva Laminati Piani (ILP), including plants at Taranto and Novi, was bought by the Riva Group
- Acciai Speciali Terni (AST), with plants in Terni and Turin, became part of Thyssenkrupp
- The tube producer Dalmine was acquired by the Techint group, owned by the Rocca family (now part of Tenaris)
- The Lucchini group acquired Piombino, Servola and other companies, establishing itself as a major stakeholder in the long product market. In 2005, Lucchini sold its majority stake to the Russian group Severstal. After Severstal's bankruptcy and the closure of the blast furnace, the site was taken over by CEVITAL, and in 2018, passed to the JSW group

Recent news about the steel industry in Italy concern the difficulties at Acciai Speciali Terni[396] due to the reduction of production volumes planned for January and February 2020. A so-called "production unloading" is expected in the Steel Plant area which will determine the Plant shutdowns (one, in this specific case) and the consequent layoff of employees. The interested plant is tone of the slabs line where semi-product coming from emerging countries are processed.
In the meanwhile, the negotiations between the Government, Trade Unions and ArcelorMittal continue for the relaunch of the Taranto site.

Improving the European steel sector's competitiveness requires an industrial policy that supports the sector at both national and European level, encouraging the creation of physical and non-physical infrastructures, supporting the levelling of costs and rules at European level and helping those companies that make circular economy their business. A key part of industrial policy concerns the relations of the steel industry with the territories and communities in which it operates in order to establish a climate of transparency and cooperation between all interested parties.

At international level, Europe must continue to work to ensure that the same environmental and social standards are applied in other parts of the world, particularly when it comes workers' rights and pay. For Italian companies, and in general for European ones, who are subject to very strict environmental and social legislation, it is difficult to compete fairly with non-EU countries, i.e. China, Russia, Turkey, etc. where these laws and rules do not exist. In fact, due to the ETS (Emission Trading System), European producers have higher costs because they are obliged to purchase CO_2 emission rights on the market. In this regard, the introduction of measures at the borders, based on the CO_2 emission content of products imported and exported from the EU, it is more urgent and necessary than ever to re-establish measures to counter unfair competition.

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[394] Balconi M, *La siderugia italiana (1945-1990) - Tra controllo pubblico e incentivi del mercato*, Fondazione Assi, Bologna, Il Mulino 1991
[395] Jan Jörmark, *Coal and Steel in Western Europe 1945-1993. Innovative Change and Institutional Adaptation*, Göteborg University Press, Göteborg, 1993
[396] Newsletter Siderweb 10/01/2020

Recently, protectionist measures, such as American duties, have also contributed to undermine the competitiveness of Italian and European companies. A more effective use of the defence instruments of the European market will help the Italian steel industry, with good foundations, to excel globally. Moreover, an effective protection policy of the EU steel market should be extended to the import of semi-finished products (slabs, billets and blooms) in terms of rules.
The current safeguard measures applied to protect the European market have proved to be inefficient, i.e. concerning the redirection of exports previously destined for the US market to the EU. Therefore, a rapid revision of these measures is necessary to increase their effectiveness.
At legislative level, it is also necessary to adapt waste legislation and to harmonise it among the various EU Member States in order to facilitate the circular economy and the re-use of steel production residues as secondary raw materials both in steel and other industrial sectors.

In a context in which non-European countries, i.e. China, produce at low quality and low price, being competitive for Europe (and therefore for Italy) means increasing the quality of products, positioning itself in the high-quality end of the market, increasing efficiency to remain competitive on price and flexibility to cover different production niches. Thanks to process and product research and investments in innovation activities, a large part of the Italian steel industry is already recognized for its excellence. Due to many reasons linked to long transition periods, there are also companies which need to improve quality and decrease reliability gaps in order to regain the trust of the market.

Current and future skills needs

According to Cedefop, "construction, manufacturing, the primary sector and utilities are expected to continue to stagnate or even decline over the entire forecast period, after the sharp decrease of 2011-16"[397]. Cedefop also highlights that the importance of high-skill jobs related to software design and implementation and/or machine programming is growing both in the services and manufacturing sectors[398]. ICT professionals[399] in the services sector show one of the highest expected employment growth rates in the medium term (2% per year between 2015 and 2020)[400].

The most appealing skills involve three main categories. These have appeared as a consequence of the market evolution resulting in changed demand patterns for certain professional profiles.

First, the need for strengthening automation in production steps calls for an increasing number of engineers with expertise in electro-technology. The demand is currently high: e.g. more than 40% of companies have difficulties in recruiting such professional profiles to fill job vacancies[401].

Second, the strong impulse towards Big Data analysis (e.g. strong growth in the amount of in-firm data warehouses) has led to significant requests for professional profiles with solid skill in mathematics and analytics (such as statisticians and actuaries). Finally, the development of ICT systems requires software and application developers as well as analysts, where the large number of vacancies remain a challenge (again, in almost 40% of companies[402]). The significant lack of such profiles is ascribed to the relatively low number of graduates in Statistics (only a small number of universities offer such degrees

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[397] Cedefop, *2018 skills forecast - Italy*, 2018
[398] Cedefop, Skills Panorama, Italy: mismatch priority occupations, 2016, https://skillspanorama.cedefop.europa.eu/en/analytical_highlights/italy-mismatch-priority-occupations, Last visited 15.05.2019
[399] Mathematicians, actuaries and statisticians (ISCO code 212), Software and applications developers and analysts (ISCO code 251), electrotechnology engineers in development of the so-called Industry 4.0) (ISCO code 215)
[400] Sistema Informativo Excelsior, Occupation forecasts 2015-2020, See: https://excelsior.unioncamere.net/, Last visited on 05.06.2019
[401] *Ibid.*
[402] *Ibid.*

and the number of students involved is limited). This problem is expected to become greater in the current Industry 4.0 scenario in both manufacturing and services. Finally, the shortage of ICT professionals has been increasing in Italy during the last 20 years. Despite being a well-known problem in Italy, no comprehensive strategy has been designed to tackle this shortage so far.

In general, the Italian labour market shows poor prospects for students wishing to follow STEM-related education programmes, as a consequence of a lack of funds and specific skills. There are generally difficulties in developing collaborations with the industry to facilitate the transition from education to the labour market.

Further aspects contributing to this are the heterogeneous quality level of educational programmes across different universities and the poor short- and medium-term prospects for engineering professionals. For instance, the average salary of an employed engineering graduate in Italy is estimated to be only 5% higher than economics graduates[403].

To compensate for the unattractive labour market for STEM-related professions, efforts have been made to align the Italian educational system to higher standards of training in technical professions and increase cooperation with the industry[404]. In 2010, specialisation technological schools (ITS) were introduced in the Italian educational system. An ITS aims to provide students with concrete technical and technological competences, which are specifically tailored to match the industrial requirements of the region where it is located. Overall, there are 86 ITS offering different programmes mainly within the STEM area; the level of education provided corresponds to level 5 of the European Qualification Framework. An analysis of the first waves of graduates reveals that these schools are very effective in providing the skills and competences required by the market and therefore offer good labour market prospects[405].

Thirdly, there is a gender gap in scientific activities (about 80% of researchers are male) as well as among university graduates[406]. To change this negative trend and stimulate the recruitment of talented professionals, the Italian Government has undertaken a series of measures:

- first, to encourage investment in R&D, tax deduction has been granted to all companies since 2015
- second, in regard to skills acquisition, a tax deduction has also been granted for companies hiring new graduates with specific contracts focused on research activities with universities, which result in finalised degrees or postgraduate degrees (such as PhDs)

These measures are expected to raise private R&D investment, even though job creation is not immediate. At a glance, the employment level in STEM occupations[407] is expected to grow faster than the Italian average in the medium term (3% increase against an average which is below 1% in the period 2014-2018)[408].

As far as steelmaking is concerned, in order for the Italian steel industry to compete internationally, talent with solid knowledge of metallurgical processes, with strong expertise to meet the increased product quality requirements is required. While technical skills are essential in the sector, soft skills are increasingly valued in the Italian steel industry. They are considered necessary to handle the commercial side of the business

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[403] Almalaurea, "Indagine sulle condizioni lavorative dei laureati", See: https://www.almalaurea.it/, Last visited on 05.06.2019. See also the recent study by CEPS "How returns from tertiary education differ by field of study", WP 4, 11, July 2015.
[404] Sistema Informativo Excelsior, https://excelsior.unioncamere.net/, Last visited on 05.06.2019
[405] Almalaurea, "2015, op. cit.
[406] *Ibid.*
[407] Engineering professionals (excluding electrotechnology (ISCO 214); Physical and earth science professionals (ISCO 211).
[408] ISFOL (Now INAPP), See: http://professionioccupazione.isfol.it, Last visited on 05.06.2019

(communication, management, languages) and, according to HR managers, they are an asset for employees to deal with the changed organisational structure of steel plants. Green skills are also in demand, due to environmental standards imposed by regulations and due to the increasing social sensitivities around the environment and sustainability. In this process, the transfer of know-how with senior-junior coaching is an effective tool, but equally powerful is reverse mentoring for the transfer of skills between younger and older people, especially for aspects related to digitisation.

Within the most developed Italian regions with low levels of unemployment, highly specialised skills are not readily available. This is because of the inadequate number of young people attending technical schools and the competition with other industrial sectors. It is easier for steel companies to find people with more basic technical skillsets (in electricity, electronics, and mechanics, which are useful for maintenance activities), but who still need additional training to become fully operational within the company. Mobility between companies of these skilled people is also very low, so non-specialist professionals are often provided by subcontractors (e. g. in refractory demolition and reconstruction), while the labour market can generally provide resources for activities related to automation and related systems.

The increased speed of development of new technologies has brought about the need for new training strategies aimed at providing workers with transversal competencies to adequately face the frequent changes in various activities. This occurs in conjunction with a new model where the industry's production areas are more and more "remote", interacting with modelling and information available through software[409]. The Italian steel industry benefits from a relatively young and qualified workforce (Italian steel professionals are on average 35, with secondary school degree skills, high enough to enable knowledge and skills flexibility).

The vast majority of Italian steel groups base their talent acquisition and HR strategy on increasing their link with local technical and professional schools and universities. Furthermore, recent policy developments[410][411] in Italian legislation seem to point towards increased attention to the needs of the industry. The process started recently, so it is only expected to provide results in a medium-long term (5-10 years) as it requires the re-building of an industrial culture, which has been abandoned for many years. Companies will need to implement a new organisational model that considers training as a resource rather than time taken away from production activities. This will facilitate the upskilling of all employees so that they at least have the basic digital and soft skills required in the industry. It will also help build a culture of continuous learning in the sector.

As a cyclical industry, steelmaking has suffered during the economic and financial crisis, with multiple restructurings and job cuts. Many competencies were lost along the way, which is a key reason for the actions needed to improve the medium-term situation of knowledge management and career development, as well as the need for solutions to retain personnel even during negative economic cycles. A potential way of stimulating tacit knowledge transfer is to further promote mentoring schemes where younger and older workers are paired together and learn from one another.

Concerning Industry 4.0, the Italian steel industry is integrating new resources in ICT by taking advantage of the national Industry 4.0 Plan, which provides companies support in the form of tax credits and easy access to finance. This enables investment in innovative tangible and intangible assets (e.g. machinery and laboratory equipment), and more

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[409] European Commission, Directorate-General for Research and Innovation, *Effect of the Near Net Shape Casting Technologies on Work Organisation, Employment Levels and Continuous Training*, ECSC Technical Steel Research – Contract No 7210-ZZ/566 – Final Report, Office for Official Publications of the European Communities, 1998

[410] See: https://www.lavoro.gov.it/temi-e-priorita/orientamento-e-formazione/focus-on/Apprendistato/Pagine/default.aspx, Last visited on 05.06.2019

[411] See: http://www.alternanza.miur.gov.it/normativa.html, Last visited on 05.06.2019

importantly, to hire highly skilled specialised and technical personnel as well as strengthen cooperation with research centres, universities and innovative SMEs[412].

Another very important issue is the culture of safety. Competence in safety is no longer only technical but is above all aimed at raising awareness at all levels and in particular at the skills that management should have in this field. This is confirmed by the safety training modules, which today are mainly focused on awareness raising.

Moreover, a scientific tool, developed by the University of Munich to map the degree of digitalisation of a company through interviewing various department heads, raises both interest and curiosity. Such a tool, on a base of 5 levels (basic, intermediate, advanced, very advanced, expert) determines the digital maturity status of a company and provides suggestions for training courses. An interesting point was highlighted by trade unions participants concerning the precariousness of employment as a strong limiting factor to the development of future skills. However, this aspect is limited in the steel industry, where there is no seasonality. Moreover, training is a qualifying point in metalworkers' collective labour agreements.

Education and training

No policies exist for the development of specific professional skills for the Italian steel industry. Upper secondary technical schools and vocational training schools have courses that provide basic skills for the steel industry. It is not unlikely that training programmes in these schools adapt to the most predominant industrial activities in their area. This also applies to the steel industry. Vocational schools, which depend on regional administrations, can more easily adapt their training programmes to the needs of the territory. Furthermore, the new laws on apprenticeships[413] and school-work alternation[414] launched in recent years could potentially deepen the relationship between schools and industry by giving students the chance to stay in a company through specifically tailored internships. As far as higher education is concerned, the engineering faculties of the universities operating in the areas of high steel industry density (Milan, Turin, Genoa, Brescia, Padua, Verona, Perugia-Terni, Etc.) all have metallurgy courses and courses on materials. Often, steel companies collaborate in the funding of research doctorates for those students who direct their studies on topics useful to the steel industry.

In the past, there was a significant gap between large and small companies concerning training. On the public side, the IRI Group, which managed State-owned steelworks through Finsider, used to have its own training centre, IRI Centre for Professional Training (CIFAP). Thousands of people of various professional levels were trained by this structure, which had premises in every city close to a steel plant. Training before entering the companies involved both blue- and white-collar workers. Even large private companies such as Falk and Fiat had their own training schools, while small steel mills started to equip themselves for the training of their employees only later, during the growth phase.

In general, it should be noted that companies organise themselves to make up for the shortcomings of VET education by participating, where possible, in the development of steel-related training programmes. Steel companies are often founding members of various post-diploma ITS (Istituto Tecnico Superiore) courses in different Italian regions. This allows companies to actively participate in the definition of training programmes. Among the shortcomings of VET education, it is stressed that they provide general and not steel-specific training. In view of the positive feedback, there has been a call for the further development of post-diploma courses and the restoration of the metallurgical course both in Technical Institutes (ITS) and in university studies. Concerning the training to meet the company's needs, a virtuous example is given by 4 Italian steel groups that have worked together on soft skills training through the joint Management 4 Steel course.

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[412] Ministero dello Sviluppo Economico, *Piano nazionale industria 4.0*, 2018
[413] See: https://www.lavoro.gov.it/temi-e-priorita/orientamento-e-formazione/focus-on/Apprendistato/Pagine/default.aspx, Last visited on 15.05.2019
[414] See: http://www.alternanza.miur.gov.it/normativa.html, Last visited on 15.05.2019

Nowadays, many steel companies have close partnerships with local VET institutions, secondary technical schools and universities, and organise in-firm trainings for their employees. This is especially true for small- and medium-sized iron and steel companies. In the past there have been examples of specific courses such as the Master in Steelmaking for newly hired graduates co-organised by universities and companies (e.g. Master funded by RIVA with the Politecnico di Torino) of which only one edition has taken place. Internal company courses include "Steel Training", a 12-month training course for permanent new recruits. The course provides both classroom and field training for steel plant maintainers and operators. The first experiment started in September 2019.

While big steelworks are still struggling with problems stemming from a poor environmental image, massive restructuring and low productivity, most small and medium-sized companies showed better resilience to the 2008 crisis. Thanks to their greater flexibility and their specialisation in specific areas of steelmaking, smaller companies have been particularly successful in investing in advanced facilities and hiring qualified personnel. As a result, the added value of their production increased significantly over the last years. In the past, a small and medium-sized steel company would rarely hire graduate staff, whereas now it is more frequent.

It should be noted that the majority of trainings are aimed at maintenance personnel, an area most exposed to frequent technological changes. Companies belonging to multinational groups have their own internal "steel universities", with structured training programmes that also provide workers the possibility of self-accessing digital modules.

The Italian association of steel producers Federacciai, created a specific body, Riconversider[415], to help its associated companies organise their courses, and gain access to public funding such as EU structural funds and Fondoimpresa, to support their training activities.

Fondimpresa is the inter-professional fund for continuing education of Confindustria (Italian National Employers organisation) and Cgil, Cisl and Uil (the three main Italian Trade Union Confederations). It is the most important organisation of its kind in Italy and is open to companies of every sector and size. Its main objective is to make training, an indispensable lever for innovation and development, simple and accessible to companies and workers[416].

A technical specialised training in the field of metallurgy and related matters is also provided by the AIM (Italian Association of Metallurgy)[417]. The Association is organised by thematic groups, which contribute to the planning of the trainings together with the Association's members belonging to the steel sector.

Furthermore, advanced courses for managers, researchers, students, trade unionists and other professionals operating across the value chain of the steel sector are provided through the Steelmaster[418] and the Eurosteelmaster[419]. The courses are organised by RINA Consulting – Centro Sviluppo Materiali S.p.A.[420][421] with the support of the European Commission, EUROFER, Federacciai and ESTEP. The participants enrolling in those courses come from steel producers, academia, unions, and companies with a vested interest in steelmaking from all over Europe and beyond.

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[415] See: http://www.riconversider.it/, Last visited on 15.05.2019
[416] See: https://www.fondimpresa.it/, Last visited on 15.05.2019
[417] See: https://www.metallurgia-italiana.net/, Last visited on 15.05.2019
[418] The course is run in Italian and has reached this year its 23rd edition
[419] The course is run in English and has reached this year its 11th edition
[420] See: https://www.rina.org/it/media/events/2018/10/01/steelmaster, Last visited on 15.05.2019
[421] See: https://www.rina.org/it/media/events/2019/04/01/eurosteelmaster, Last visited on 15.05.2019

In Italy, the public technical education system (Technical secondary schools) is under the direct control of the national government, while the public VET system is mainly under the control of regional administrations.

After the economic boom, both types of technical schools suffered a long and continuous degradation in the 1970s, due to the scarce attention that the national and regional authorities dedicated to them. Also, families and youth were increasingly gravitating towards schools considered of greater prestige and more suitable to prepare students for economics-oriented faculties. Technical and professional schools gradually removed their courses related to the steel industry, with serious consequences for this sector. When the steel sector emerged from the period of stagnation seen in the 1970s and 1980s, it experienced great difficulties in finding, attracting and retaining qualified personnel.

Recently, the Italian government decided to update and reinforce the VET system that had been greatly damaged in the past decades. In this process, a stronger cooperation between companies and technical schools was established. This led to the introduction of an internship period in a company of choice for technical school students. New legislation was also dedicated to apprenticeship and dual learning schemes.

In the past decades (1960s – 1980s), many Italian students and young graduates already employed in the steel sector (i.e. companies, research centres), attended masters or research doctorates in European and overseas universities (e.g. Germany, the UK, the US, Japan) with the financial support of the companies themselves. At present, this trend is declining because various Italian universities and research centres can provide in-depth knowledge of the metallurgical field. Nowadays, only multinational companies foresee a mobility scheme when training (or re-training) their highly specialised personnel.

2017 was a positive year for the training activities organised by Riconversider[422] for Italian steel companies. It was characterised by an increase in company operating activities as regards the financing of sectorial and territorial training plans of Fondimpresa[423] that have brought growth in total corporate turnover. The Training Plans financed by the two regions with which Riconversider currently operates - Lombardy and Veneto - and those of direct consultancy to businesses, remained the same.

In particular, the sectoral and territorial training plans presented to Fondimpresa were increased both in terms of quantity of plans (11 Plans in 2017 compared to 9 in 2016), and in terms of funding requested (EUR 2.3 million in 2017 compared to EUR 2 million in 2016).

As regards the activities developed, over 350 training actions for a total duration of 11,217 teaching hours involving 300 companies and over 1,400 company employees were trained on the following topics:

- qualification of production processes and products;
- organisational innovation;
- digitalisation of business processes;
- internationalisation;
- environmental sustainability.

This increase in activity had an impact on the overall company turnover that went from EUR 2.3 million in 2016 to EUR 2.6 million in 2017, also against a slight decrease in consulting activities. An important development that took place in 2017 is the design of the first Master programme in Metallurgy.

Training projects are being planned for unemployed and new technical graduates. For example, "Giovani d'Acciaio" by RICONVERSIDER offers a professional path for young technical graduates. The course includes 30 to 40 days in the classroom + modules for the

[422] See: http://www.riconversider.it/, Last visited on 05.06.2019
[423] See: https://www.fondimpresa.it/, Last visited on 05.06.2019

development of soft skills and provides a qualification as an operator specialised in steel processes.

Big companies have their own training centres and have direct access to the regional funds (EU structural funds) for training their personnel. This is the case of Acciai Speciali Terni. For other big companies like Aferpi and ILVA (now Arcelor Mittal Italia), as previously mentioned, the last years have been a very difficult period and training has been neglected if not abandoned. Now, there has been a re-establishment of contact and cooperation with the local public education and VET system and access to both regional funds and Fondoimpresa will be possible. Although far from the dual training system adopted by other European countries, the direction that ongoing initiatives have taken is very positive. Hopefully, other large companies should soon return to stable and continuous training activities in collaboration with regional institutions and with the school system of technical and professional training. By improving its image, more talent should find its way to the sector, which in turn should make collaborations between educational institutions and companies more attractive.

Although national legislation and regional training programmes that draw on EU structural funds are not specific initiatives for the steel industry, in areas with large numbers of steel companies it is possible to direct training programmes towards the needs of the steel industry as illustrated by the examples above. Greater dissemination of best practices would be needed to speed up the process of improving training in the sector. The Italian iron and steel industry, assisted by Riconversider and the other bodies that organise training initiatives in the sector (Italian Metallurgy Association, Steelmaster and Eurosteelmaster) can contribute substantially to such efforts. Future training efforts should also encourage a culture of safety at all professional levels by organising specific training qualifications in safety. Efforts are currently underway for this.

The image of the steel sector

The image of the steel sector is currently negative and does not reflect what Italy is doing in this field, especially in terms of circular economy and sustainability. The steel sector is perceived as old, obsolete from the point of view of production processes and characterised by mainly manual, heavy and hard work. Moreover, the steel industry is considered as not very environmentally friendly: it pollutes, it is energy-consuming, it generates emissions that are difficult to recycle. Overall, its impact on the environment is perceived as very negative. In general, people prefer not to live near iron and steel sites, without distinction between the type of production: the integral cycle (more polluting, present only in a small part of Italy) and the electric furnace cycle (less polluting, more common). Despite more than 80% of Italy's production being electric furnace steel, there is an excess of attention for integral cycle production, which is increasingly marginal.

The image of steel in Italy has deteriorated over the last decade, mainly due to the events at the ILVA steelwork in Taranto, where the environmental impact of production activities was heavily criticised in national media. The situation appears to be returning to normal, but the negative impact on national public opinion persists. Local trade union representatives interviewed in this study confirmed that, even now, the bad environmental reputation of the steelwork industry affects the availability of workers at all skill levels. In particular, among young workers and jobseekers, reluctance to work in a steel plant remains high[424]. In addition, the 1,400 temporary layoffs announced by ArcelorMittal in June 2019 sparked new protests among workers and national unions.

More generally, traditional media tend to emphasise negative news rather the positive ones, i.e. technological innovations carried out to reduce environmental impact and/or increase productivity. Moreover, the steel industry is subject to political speculation, especially during election season in the areas where plants are located. Politicians often ride the wave of the "Taranto effect", that is the great environmental problems affecting

[424] Interview notes - Workers' Organisations, Senior representative at FIOM CGIL Taranto

citizens' health in Taranto. In addition, ineffective communication of companies towards the public has also negatively affected perceptions about the sector: avant-garde projects are not well explained and do not use proper terminology, which in turn leads to wrong external perceptions, e.g. "steel mill slag" is often associated with radioactive waste and related health hazards. Companies and trade unions should showcase the results achieved, both in terms of the sector's productivity and improvements in worker protection and environmental sustainability. The Arvedi steelworks in Italy represent a good example. The group has announced its intention to achieve carbon neutrality by 2023, the first steel company in the world to set such a goal. Such news should be advertised through newspapers and on social media, which are very popular with young people.

Another important aspect affecting the sectors' image is the distrust of the control instruments that are put in place to ensure compliance with applicable laws. In addition to European rules, each Member State has its own laws; Italy has the strictest rules in Europe and each Region has very restrictive controls. Unfortunately, in some cases, laws and rules are not respected and infringements are not always detected by control bodies, which compound the damage to the sector's image. Such cases have led to the involvement of the judiciary, which in turn has attracted negative media coverage and led to a loss of confidence in the control authorities.

In other steel producing areas, the situation is more positive, and steel companies have more collaborative relationships with local stakeholders. On average, steel companies find more favourable market conditions in Southern Italy than in the northern regions, where due to a more developed labour market, they face harsher competition, which makes it harder to employ and retain young and qualified talents. This has been identified as a key challenge for the Italian steel industry by many stakeholders from industry and academia, with several claiming that the industry needs a stronger supply of young personnel, especially in qualified R&D positions[425].

The positive aspects of a career in the steel industry differ depending on the professional level of workers and on the type of work they perform in the companies. For blue-collar workers, positive aspects are the greater solidity of the employment relationship compared to other sectors of the economy, a generally higher and more reliable salary level than in other industrial workplaces, and a stronger union representation, which allows for an increased awareness of workers' rights and greater attention to the work environment and work organisation. Nonetheless, according to participants in the national workshop, while salary levels are not bad, they have not evolved sufficiently with the increase in the cost of living over the past 20 years. As for more specialised profiles, especially those technical and administrative roles that are not affected by shift work, the attractiveness of working in the iron and steel industry is linked to the complexity of production processes, the continuous development of new products, the increasingly high levels of process automation, the continuous increase in production quality, and rather solid contractual conditions.

The crisis that hit the manufacturing sector in the 1970s had a particularly strong impact on the steel industry, which experienced an extended period of mass layoffs and career stagnation during the 1980s. As a result, the image of the industry worsened dramatically. Before the crisis, the Italian steelmaking industry was considered a reliable source of stable jobs, which would sustain entire families for generations. After the 1980s, even those local communities traditionally tied to the iron and steel plants active in their regions started to gradually lose confidence in the reliability of steel companies as employers. Nevertheless, the industry remains a key employer in the areas where the main steelworks are based (e.g. Taranto, Terni and Piombino, Lombardy and Veneto)[426].

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[425] Interview notes - Education Providers, Senior researcher in the ICT and industrial research centre at Sant'Anna University

[426] Interview notes - Education Providers, Director of a steel-related training programme and former ECSC official

Jobs in steelmaking are still affected by many prejudices and misconceptions, especially those blue-collar positions that are associated with harsh working conditions and poor work-life balance. These factors play an important role in discouraging jobseekers, especially young people and women. Companies and trade unions should invest more resources in showcasing avant-garde projects both at the company as well as at the sectoral level to change perceptions of the sector. Good examples from abroad should also be mentioned, for example in Linz. Here the steel plant, one of the "greenest" in Europe, is located in the city centre. There are plenty of other examples where European full cycle plants operate in harmony with the communities living there which should also be advertised.

In order to attract young talents in the sector, efforts should focus on showing them what kind of opportunities exist (focusing on training and personal growth) and the efforts that are being made by the sector to decrease its environmental footprint. It is necessary to start early on at school with such campaigns (especially technical colleges and STEM faculties). Companies should organize open days, or equivalent initiatives, aimed at families and students starting from primary school, which will also help to build a relationship of trust with the community.

In the latest instalment of its sustainability report, the Italian steel producers' association Federacciai highlights several best practices in the area of social responsibility that were undertaken by its member organisations[427]. These include initiatives and projects aimed towards promoting social, cultural and educational development in the area where companies are operating. The overall goal was to improve the image of the steel sector and recreate ties with local communities. Several initiatives have been carried out to involve young people from high schools and universities and showcase the many career opportunities available in steelmaking. The most relevant initiatives include:

- **Fondazione Dalmine:** The foundation was created by Dalmine SpA to promote industrial culture in the Dalmine and Bergamo areas. The foundation organises multiple cultural activities, including workshops, visits, projects for pre-school, primary school and high school students (see, for instance, the project "3-19", mentioned in Table 8)

- **Trainings and real-life projects:** Taking advantage of the school-work alternation programme introduced in 2015 by the Italian Government, several companies in Northern Italy have launched activities with local high schools to bring students closer to steelmaking. Specific examples are the Feralpi Bootcamp project organised by the Feralpi Group and the Delta Junior project, launched by the Lucchini Group in 2016 (for more information, see Table 8)

- **Field visits:** Another common practice among Italian steelmakers is to organise field visits with local schools and universities to expose students to the day-to-day reality of working in a steel plant. The Marcegaglia and Arvedi groups entertain regular partnerships with local schools, while AST Terni has recently concluded a partnership with the University of Perugia to jointly organise a three-month programme in Metallurgical and Steel Technologies[428]

In conclusion, the relaunch of the sector requires investments in environmental, economic and social sustainability.

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[427] Federacciai, *Rapporto di sostenibilità 2017*, 2017, pp. 101 - 117

[428] Siderweb, "Terni, AST e università insieme per la crescita", 27.02.2019, See: https://www.siderweb.com/articoli/industry/702203-terni-ast-e-universita-insieme-per-la-crescita, Last visited on 14.06.2019

7.3.5. The Netherlands

The steel industry and its competitiveness

Internationally, the Netherlands is the 14th largest steel exporter[429], with exports of 11.3 million tonnes of steel, according to the American International Trade Administration. On the European scene, the Netherlands accounts for 4% of the EU's production of crude steel[430]. Other indexes attest to the importance of the steel industry in the Netherlands, notably the number of jobs it supports, amounting to 50,400[431] (of which 9,242 are direct jobs[432], the remainder being indirect and induced jobs).

In the Dutch economy, one steel company stands out: India-owned Tata Steel, which bought formerly UK-owned Corus Steel plants in IJmuiden, and is now named Tata Steel Europe, the main steel producer. Other companies such as ArcelorMittal and Thyssenkrupp are also located in the Netherlands. The IJmuiden steel plant is the largest industrial site in the Netherlands with 750 hectares of land and its own inner and outer harbour facilities. Tata Steel Europe produces steel for four main markets: the engineering sector, the construction industry, the automotive sector and the packaging industry. In January 2019, Tata Steel's IJmuiden plant was recognised as a "Manufacturing Lighthouse" by the WEF, acknowledging "state-of-the-art production facilities which successfully adopt and integrate the cutting-edge technologies of the future and drive financial and operational impact"[433]. Sixteen plants in the world have been awarded this distinction and form a network of "learning platforms for production".

In the aftermath of the economic crisis of 2009 and the flooding of the market with cheap steel products from Eastern Europe and Asia, the Dutch steel sector found itself in a vulnerable position. To remain competitive, different measures were taken by the steel sector, and notably by Tata Steel Europe: a more customer-oriented focus and more R&D, to gain a competitive edge and reduce greenhouse gas emissions. Currently, its R&D department in the Netherlands employs 500 researchers. In its efforts to become more customer-oriented, Tata Steel Europe has tried to develop a new mindset and change its approach to customers and to steel production. With its automotive clients, the company ensures close interaction by inviting its clients to the Product Application Centre and receiving "Bodies in White", i.e. vehicles. In this Product Application Centre, R&D staff from both Tata Steel Europe and the client company work together on new parts, in a process known as "kitchen-to-kitchen"[434]. Moreover, R&D investments have led the company to implement a pilot project at the IJmuiden plant in 2011, in which new technology is used to make iron using bath-smelting technology. In this process, the iron ore and coal are directly melted into the reactor, thereby requiring less coal and therefore reducing energy consumption and greenhouse gas emissions. This new iron-making process is called HIsarna[435]. These priorities are echoed by an expert working in the public sector related to steel, as according to him, the sector has improved in terms of efficiency over the years as it has managed to develop shorter production areas thanks to a series of innovations. He has also witnessed changes in requirements on sustainability, which are slowly becoming more demanding.

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[429] According to data collected in 2017
[430] EUROFER, *European Steel in Figures 2019*, 2019
[431] Oxford Economics, *The impact of the European steel industry on the EU economy*, published by EUROFER, 2016
[432] EUROFER, 2018, op.cit.
[433] See: https://economictimes.indiatimes.com/industry/indl-goods/svs/steel/world-economic-forum-recognises-tata-steels-netherlands-plant-as-factory-of-the-future/articleshow/67477377.cms?from=mdr, Last visited on 22.03.2019
[434] Brouwer, J.J., Van Der Zwan G., *The Dutch Industrial Landscape: 50 inspiring business cases*, Mainpress BV, 2011, pp 127-128
[435] See: https://ww2.frost.com/frost-perspectives/challenges-and-opportunities-in-the-steel-industry/, Last visited on 15.03.2019

Current and future skills needs

In order to ensure that the objectives of this transition are reached, the steel sector must ensure that its employees possess the right skillset. The sector is currently undergoing a digital transformation and requires employees that can deal with a range of different technologies. The main trends in the Dutch labour market that also affect the steel sector are the shortage of technologists and the ageing workforce. Technologists are defined as "people who make 'practical' or real use of one or more technologies, working for instance, as lab technicians, researchers, instrument makers, ICT professionals, planners, industrial designers (creative), plumbers, engineers, operations or analysts". Due to this shortage, positions are left vacant as older employees retire.

While technical skills will always remain necessary to work in the sector, repetitive tasks will be taken over by AI in the future. In light of this development, soft skills like teamwork, leadership, flexibility and critical thinking will become more important. A compilation of different sources, including academic papers, national policy roadmaps, and specialised statistical reports, show that the Dutch steel workforce lacks some of these skills, which are necessary for the industry to remain competitive. The specific skills needs pertaining to the Dutch steel sector are described in detail in the next paragraphs.

At national level, the Dutch Research Centre for Education and the Labour Market (ROA), a research institute of the Maastricht University School of Business and Economics, is specialised in the foresight of labour trends. The online statistical database reveals that, for the period between 2017 and 2022, there is an expected bottleneck in engineering professions. This indicator, known as Future Staffing Bottlenecks by Occupation, gives the probability that the demand for a certain occupational group cannot be met in terms of educational composition. This means that not enough qualified graduating students will be available to fill-in all the available engineer positions in different sectors, including the steel industry. Another interesting indicator compiled by this research institute is the expected training bottlenecks, which shows the shortages in educational qualifications pertaining to each sector. In the metal sector, the training bottleneck is expected to be large for preparatory vocational secondary education (VMBO) in technology. The training bottleneck is expected to be very large for MBO 4 in mechanical engineering and metalworking (which corresponds to higher levels of vocational education). In other words, a very large shortage of MBO 4 graduates is expected in the metal sector. These anticipated shortages translate into shortages of skilled employable labour for the metal industry. ROA's online statistical data also provides an assessment of the current workforce's core skills, evaluating the following:

- Use of computers at work: the percentage of employees who indicate that they use a computer at work
- Language proficiency: the ability to read and understand written texts and to be able to act adequately on that information. This index measures the elementary skills required to understand the meaning of a written text
- Numeracy: the ability to read, use, understand and communicate mathematical information and ideas to deal adequately with daily numerical requirements
- Problem solving ability in digital environments: the ability to use digital technology to solve practical problems that people encounter in daily situations

These core skills have been assessed by ROA in 2012 at the industrial level, but also for more defined job clusters[436]:

- In the more general "metal industry", all of these core skills are qualified as "average"

[436] See: http://roastatistics.maastrichtuniversity.nl/AIS/home.aspx, Last visited on 28.03.2019

- At the more specific level of the professional group of "welders and metal sheet workers", these skills are evaluated as "low"
- For the professional group named "metal workers and construction workers", these skills are assessed as "very low", except for the use of a computer at work, which is qualified as "low"

This skills gap is confirmed by an expert working in the public sector on labour policies. According to him, every technical and manufacturing industry faces skills gaps and mismatches, because of a variety of factors:

- Worldwide technical development and digitalisation (the amount of new technologies, but also the speed of developments)
- The financing mechanism of the Dutch education system, which is based on the government providing a lump sum to universities based on the number of students that graduate. However, some programmes are more expensive to implement, which means that they are not so easily updated (this includes technical programmes)
- Lack of younger teachers: most teachers are now from an older generation and are less able to keep up with new technologies or are less up to date about the requirements of the industry
- Lack of learning culture in companies and employees (particularly lifelong learning)
- The necessity for the (steel) industry to be competitive at global level, which reduces the resources to support lifelong learning

These skills gaps are problematic as automation has transformed traditional manual work into non-manual work in most industries in developed economies. This is also true of the steel sector, which requires qualified workers capable of using, monitoring and maintaining new machines[437]. Skills such as interpreting data from a machine are also required. Lower-skilled employees that have traditionally executed manual work risk being left behind if they are not upskilled. In turn, these skills shortages create occupational bottlenecks. A study conducted by Cedefop mentions several bottleneck occupations in the Dutch manufacturing industry, including science and engineering professionals, installers, repairers, machine operators and assemblers. As previously mentioned, this mismatch can for the most part be attributed to the retirement of baby boomers and the lack of expected graduates from vocational education in these fields[438]. Another reason for these occupational shortages is that students have a negative image of the working conditions manufacturing industries (including steel).

Experts with different backgrounds (from academia, the public sector, and the steel industry) interviewed during this project concur with these findings, and also listed several other skills that are or will be needed in the Dutch steel sector. For instance, the expert working on labour policies for the public sector explained the following:

- *"…predictive maintenance and smart maintenance as two key skills for the current and future steel industry. Related to them is also data analysis. For all industries, it seems important for students to gain an entrepreneurial mindset (be business-ready)."*

Another person working in academia, highlights that:

- *"Market skills are essential: you cannot only produce, you also need to understand what the needs for downstream industries and people in general are so that you can improve your products (e.g. different types of steel) and increase the opportunities to use steel in the market. Market skills have to be*

[437] *Ibid.*
[438] Cedefop, "The Netherlands: Mismatch priority occupations'", Skills Panorama, 2016, See: https://skillspanorama.cedefop.europa.eu/en/countries/netherlands, Last visited on 27.03.2019

taught also to ensure that future industry employees make the most of the different associations of industries that are active in the Netherlands (e.g. trade associations, etc.)."

- As for skills needs appearing in the next five years, he mentioned the need to employ innovative people who can increase the sector's sustainability.

Finally, an expert working in steel production highlights that the main current skills needs relate to the following:

- *"21st Century skills: critical thinking, problem solving, creativity, supporting digital procedures. Because things are changing and nowadays, we work mostly with computers"*

ROA's online statistical database also provides previsions about the labour market in terms of professional groups. The categories "welders and metal sheet workers" and "metal workers and construction workers" are the most relevant to the steel sector. The following indicators are measured for these two groups:

- The expected expansion of employment demand until 2022 is low for both professional groups
- The expected labour replacement demand until 2022 is high for the two professional categories
- The career perspective index (measured by comparing the gross hourly wages of working people in the 40-49 age group with the gross hourly wage of working people in the 20-29 age group) differs according to the professional group. For welders and metal sheet workers, it is qualified as bad, whereas for metal workers and construction workers it is characterised as reasonable
- Substitution opportunities by type of education (i.e. the extent to which employers can attract workers for a specific profession with a diverse educational background) is low for both professional groups

These statistical analyses show that professional opportunities for these groups exist mainly because of the retirement of baby boomers rather than the growth of the steel market. It also indicates that these lower-skill employees need to be upskilled to avoid being left behind by the digital revolution taking place in the industry. These forecasts are coherent with the findings from other sources such as academic papers and national reports.

Education and training

National measures

At national level, the ROA is the most well-known institution for skills anticipation and labour market forecasts in the Netherlands. Their forecasts enable the actors in the labour market to act accordingly, including employers, education providers, employment services providers and prospective candidates.

To ensure that efforts by different stakeholders are streamlined, Dutch technology stakeholders have agreed to a "Technology Pact". This pact has been developed by the Dutch central government, trade unions, employers and employees of the technology-relevant "Top-Sectors", education providers and the five regions to overcome the shortages of skills and of graduates in technology-related fields. It is centred around three lines of action to be accomplished by 2020[439]:

[439] See: https://www.techniekpact.nl/nationaal-techniekpact-2020, Last visited on 15.03.2019

- "Choosing technology": increasing the number of pupils who choose to study in the field of technology
- "Learning in technology": increasing the number of pupils and students with a technical qualification progressing to a job in technology
- "Working in technology": improving the retention of people working in technology and employing people with a technology background who face the threat of unemployment

To achieve these overarching objectives, many measures have been taken by the stakeholders of the "Technology Pact". For instance, these stakeholders collaborate to strengthen technical vocational education, emphasising links between schools and business communities. This has been done by having representatives from companies teaching electives at schools or by arranging traineeships where students are paired up with experienced employees. They have also established 1,000 annual scholarships for study programmes related to technology in universities of applied sciences and research universities and have produced plans to increase re-employment of qualified technologists recently laid off. As explained by an expert working in the public sector,

> *"In order to solve some of the issues that create the skills gaps it is necessary to bring people together: the triple helix stakeholders should have a continuous dialogue about the mismatches and the approach to solve them. There are facilitation programmes at national level, which are then operationalised at regional level. In North Holland, they support "campuses" where industry, local public authorities and education providers work together on a daily basis to discuss the content of curricula and find ways to ensure students have the right skillset. For steel, such a campus is Techport. Encouraging these triple helix organisations in several regions to work together on topics such as image, educational crossovers and professional careers will lead to a strong learning community."*

Moreover, to achieve the objectives of the Pact, a list of specific goals has been defined. Tata Steel Europe is active in achieving Goal 7[440] "Education and business work together to train vocational education teachers". To achieve this goal, a network of different schools, government representatives, companies and partners of the "Technology Pact" was created. Named the Youth and Technology Network of the Netherlands, their goal was to share knowledge and develop relevant and valuable curricula in different sectors, including the steel sector. An employee of Tata Steel Europe, working in the Learning and Development department at the IJmuiden plant is the project leader. The objective is for this network of different stakeholders to design teaching material and provide trainings to educational providers, ensuring that education matches industry requirements.

In the context of the 'Technology Pact' several reforms of existing curricula have been implemented. Looking at the Dutch educational offer, after completing primary education (compulsory between 5 and 12), children choose their secondary education between the following:

- Preparatory vocational secondary education (VMBO)
- General secondary education (HAVO)
- University preparatory education (VWO)

In terms of post-secondary levels, the choices are:

- Four levels of MBO:
  - Level 1: entry level

[440] See: https://www.techniekpact.nl/cases/vohonetwerk-amsterdam-tata-steel-verzorgt-opleidingen-docenten-beroepsonderwijs, Last visited on 15.03.2019

- Level 2: basic vocational training
- Level 3: full professional training
- Level 4: middle-management and specialised training

- Universities of applied sciences (HBO)
- Research universities (WO)

Steel-related courses may be taken by students of both MBO programmes (for instance, welders programmes) and university programmes (such as mechanical engineering bachelors).

In terms of VET, the Netherlands offers a range of possibilities. In MBO, students may choose between different paths (school-based or apprenticeships), between different programme levels and areas of study such as green/agriculture, technology, economics and health/welfare, as well as the possibilities for future studies. Different actions have been taken by the government to ensure that the curricula match labour realities. For instance, the Ministry for Education, Culture and Science initiated the Focus on Craftmanship action plan 2011-2015 (Focus op Vakmanschap 2011-15), to simplify the educational system and improve the quality of education by increasing teaching time, improving the exams, strengthening career guidance and simplifying the qualification framework[441].

The same Ministry also set up the Samenwerkingsorganisatie Beroepsonderwijs Bedrijfsleven (SBB) in 2012 in an effort to better match industry requirements with the curricula. SBB is an organisation that acts as the link between VET institutions and industries and is composed of stakeholders from the educational sector, social partners and industry representatives, organised in eight sectoral chambers. Each of these groups is responsible for the recognition of companies offering internships and work placements and is in charge of supervising the qualifications delivered by VET institutions in their sector[442].

Moreover, improving the efficiency of VET is also high on the policy agenda in the Netherlands, as the introduction of a new performance-based funding system attests. To incentivise VET institutions to provide courses that lead to employment, the funding of the VET institutions depends on the rates of employment of graduating students. The objective is to discourage schools enrolling too many students in popular programmes without real job prospects. In addition, the length of MBO programmes has been reduced, with the objective of reducing students' transit through the VET track and bringing them to the job market faster, while increasing the study load. For instance, most MBO 4 programmes, traditionally requiring four years of study, have been reduced to three years, MBO 3 programmes last maximum three years, and MBO 2 programmes require two years[443].

A new qualification system has also been implemented since August 2016, based on a revision of the previous one, to simplify and improve the qualification system[444]. In this new framework, the definition of qualifications is broader, to allow VET institutions to adapt the content of the curricula more easily to meet industry requirements in terms of skills. The new qualification system includes three broad parts: a general part with language, numeracy, citizenship and career management skills, a vocational part applicable to all profiles of the qualification and profile modules composed of compulsory and optional modules specifically linked to the profile within the qualification. The optional modules are jointly developed by industry professionals and educational providers to swiftly react to

[441] Cedefop, *Vocational education and training in the Netherlands: Short description*, Luxembourg: Publications Office of the European Union, 2016
[442] *Ibid.*
[443] *Ibid.*
[444] *Ibid.*

labour market needs. As a result of this simplification, 176 qualifications and 489 profiles remain, which represents a 25% reduction according to the study.

On the lifelong learning side, i.e. to upskill and reskill employees, the Dutch metal sectoral organisation Koninklijke Metaalunie and the sectoral training fund for the metal industry Opleidings- en Ontwikkelingsfonds voor de Metaalbewerking (OOM) have defined the skills needs and learning objectives of metal professionals[445]. This new framework is based on metal companies' input on the various jobs and skills requirements of the sector and is now used as the baseline to monitor and develop skills in this sector. Moreover, OOM organises trainings and seminars for workers of the metal industry, addressing new skills requirements linked to innovations in the sector. For instance, OOM organises trainings on the use of new machines and new techniques to ensure that workers are equipped with the right skills in light of the digitalisation of the industry.

At the company level, to recruit more skilled employees and upskill the workforce at the IJmuiden plant, Tata Steel Europe raised the lowest qualification possible (Level 1) to the next level (Level 2), which establishes Dutch reading and speaking skills as compulsory[446]. To do this, Tata Steel Europe stopped recruiting at Level 1, and offered training schemes to Level 1 employees to upskill them. By implementing this change, Tata Steel Europe ensures that even the lowest qualified workers speak and read Dutch, which is essential for security reasons. Tata Steel Europe also funds different types of traineeships (technical and business) and apprenticeships (in mechanical engineering, electrical engineering, logistics, process technology) for high school and university students (for instance Nanoscience Master Students of the University of Groningen) to train them on specific techniques and immerse them in the working place before they fill an official position in the company. To accommodate the apprentices, the IJmuiden plant has a dedicated Training Centre, with simulation laboratories that are used to experience bench working for example.

According to an interviewee working on labour policies in the public sector, the strategies highlighted above, such as the triple helix forms of collaborations and Tata Steel Europe's trainings, are successful at bridging the skill gaps:

> *"the current educational offer matches the requirements of the steelmaking industry at the moment because the dialogue between stakeholders (e.g. Techport) has been going on for years. Furthermore, Tata has its own company school, which ensures the connection between the needs of the market and the skills of students. This academy is also linked to other technical schools in the area now and they are creating programmes together to ensure the market fit."*

Given that the most effective way of learning the necessary skills is in the field, many companies have started organising their plants following a "team form of organisation"[447], which requires staff to multi-task, exchange roles and support colleagues when needed. The Tata Steel plant in Ijmuiden is organised in this fashion. Moving from a "single task" type of work organisation, where workers had unique tasks to perform, meant that the company had to provide specific training so employees can multi-task and work within a team. By creating teams that are multidisciplinary and autonomous (no manager), members can learn from each other in a safe environment. Research has shown that under this setup employees feel more satisfied with their jobs. It can also help avoid that low-skill employees are left behind.

In addition to team building skills, it also requires mentoring to improve the social side of the work organisation. This is linked to the ageing of the workforce, with many experienced

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[445] OECD, *Skills Strategy Diagnostic Report: The Netherlands,* OECD Publishing, Paris, 2017
[446] Fairbrother P., Stroud D., Coffey A., 'Skills, Qualifications and Training in the Netherlands Steel Industry: A Case Study', Working Paper Series, Paper 58, 2004
[447] *Ibid.*, p.13

and skilled employees such as welders retiring, and the need to pass on their expertise to newer generations of steel workers. It is expected that 70,000 metal workers, construction workers, installers, electricians, engineers and system analysts will be retiring every year up to 2020, and that the education system does not provide enough skilled people to replace them[448]. Without an effective mentoring scheme, the specific knowledge accumulated over the years in terms of techniques will be lost. It is important for the sector to find ways to retain the knowledge and experience built over the last decades. While many companies have already started formalising knowledge, the process is far from complete. Several educational intermediaries have already stepped in to facilitate this process. For example, FME has been formalising knowledge with companies by recording their knowledge and developing modules which are then made available to employees via FME's platform, *Ozone*.

Nevertheless, these strategies are only a starting point, and triple helix collaborations should be extended at the regional level. Knowledge exchanges should be further encouraged to anticipate skills gaps. Traditionally, training initiatives have emerged as a reaction to market developments. Management and trade unions should also address the effects of an increasingly diverse workforce. According to the research team who led a study at the IJmuiden plant, such HR strategies are lacking despite the increased diversity of the workforce. For example, while the number of women working in the sector has increased, numbers remain low. In the Netherlands, appeal is low among women as they feel that it does not offer them flexibility (e.g. the possibility of part-time work to also be able to spend time with their children). These changes in workforce composition should also be reflected in companies' training programs[449].

Regional measures

Specific regional measures, supported by the ERDF[450], aim to "boost the region's potential for Research and Innovation (R&I) while at the same time contributing to the development of a resource efficient, low-carbon economy" in the region of Western-Netherlands, which consists of the provinces Zuid-Holland, Noord-Holland (where the IJmuiden plant is located), Utrecht and Flevoland. For the period 2014-2020, EUR 189,847,057 has been allocated to this region. Among the funding priorities, one is particularly linked to this project: the allocation of ERDF funds in this Dutch region will serve to "reduce the mismatch in the labour market by locally connecting enterprises to knowledge institutions"[451]. In light of this funding objective, different projects have been supported. For instance, Kiezen Voor Kansen Den Haag[452] (Opting for opportunities in the Hague) brings together companies and education providers of the Hague to encourage young students to participate in internships in sectors facing occupation shortages and thereby discover sectors and jobs that they might not have known otherwise. Another example of a project supported by the same funding line is Verbonden met Zuid[453] (Connected to the South). This project brings together early school leavers older than 16, who are unemployed and without qualifications, employers from sectors such as healthcare and technology with vacancies to fill, and education providers. Together, they develop tailored apprenticeships for unemployed young adults. European funds therefore actively support measures to up-/reskill people, and therefore bridge the gaps between demand and supply of labour in the Netherlands.

European funds have also been allocated to support projects in the Dutch steel sector that increase safety awareness at the workplace. Some of the skills mentioned above are not only required to increase the competitiveness of the industry, but also to ensure a safe

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[448] See: https://www.techniekpact.nl/wp-content/uploads/2014/03/Dutch-Technology-Pact-Summary.pdf, Last visited on 27.03.2019

[449] Fairbrother P., Stroud D., Coffey A., 'Skills, Qualifications and Training in the Netherlands Steel Industry: A Case Study', Working Paper Series, Paper 58, 2004

[450] See: https://ec.europa.eu/regional_policy/en/atlas/programmes/2014-2020/netherlands/2014nl16rfop002, Last visited on 26.03.2019

[451] *Ibid.*

[452] See: https://www.europaomdehoek.nl/projecten/kiezen-voor-kansen-den-haag, Last visited on 26/03/2019

[453] *Ibid.*

work environment. In the Dutch steel industry, several low-skilled positions are occupied by non-Dutch speaking workers notably from Spain, Morocco, Turkey. They operate dangerous machines and tools to melt metal and cut steel plates but there is a risk that Dutch safety rules and regulations are not understood, which could lead to a dangerous professional environment for all employees. In a study conducted at Tata Steel's IJmuiden plant, researchers stressed the recently acknowledged importance, by the sector, of employing staff that can speak and read Dutch for safety reasons[454]. Dutch educational bodies have also started providing the mandatory safety training that is required to work in the industry in candidates' mother tongue.

Under the ESF, a project was implemented by Tata Steel Europe between 2015 and 2016 to improve employees' knowledge and skills related to safety[455]. According to the project description, before its implementation, employees were not aware of the potential risks linked to the working environment. After the project was completed, Tata Steel Europe factories across the country scored highly on safety-related criteria, indicating that the project was successful. Nonetheless, many of the project's Dutch stakeholders mentioned that European funds are complex to obtain and require excessive administration. This may indicate that European funds are being underused. They also mentioned that European funds are too regionally focused. If Europe wants to compete with other steel-producing countries a European approach is necessary that focuses on quality, preserving the environment and on decent working conditions.

The image of the steel sector

Based on desk research, it appears that the steel sector is unattractive in the minds of young adults. According to the Dutch Technology Pact 2020, people imagine this technological sector to be "boring, difficult, complex, or you'll have to get your hands dirty"[456]. The negative perception that the general public has can largely be attributed to a lack of familiarity with the work in the sector.

Companies are attempting to change this perception by focusing on more positive aspects, especially in their job advertisements. Steel companies now promote the versatile nature of daily tasks, insisting on the fact that every day is different and provides exciting opportunities. This is also recommended by an interviewee working in the Dutch public sector, who explained that improving the image of the sector could be achieved by presenting the innovative character and diversity of careers within the industry to parents of the next generation of students. He emphasised the importance of explaining that interesting career evolutions exist in the industry. According to his experience, companies should show that people can grow in their functions, or for instance, be outsourced, to experience new environments (for example, through agreements between the industry, its suppliers and neighbouring technical sectors to foster job rotation and increase career prospects).

Moreover, according to a professor interviewed during this study, it is important to increase awareness of the general public, and of policy makers, on the benefits of steel. Steel is everywhere and it is tangible; it connects people and helps to solve societal problems. It can also help to complete the transition to a circular economy. Campaigns should be set up to showcase the importance of steel in a large variety of products and to show the public that steel is not as "dirty" as they perceive. It is in fact one of the most recycled products in the world. The expert suggested conveying the message that steelmaking companies are "cleaning the planet by means of scrap steel". He highlighted the need for an intelligent promotion of steel and steel use through computer games and tv series to indirectly reach

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[454] Fairbrother P., Stroud D., Coffey A., 'Skills, Qualifications and Training in the Netherlands Steel Industry: A Case Study', Working Paper Series, Paper 58, 2004

[455] See: https://www.europaomdehoek.nl/projecten/verhogen-veiligheidsbewustzijn-op-de-werkvloer, Last visited on 26.03.2019

[456] See: https://www.techniekpact.nl/wp-content/uploads/2014/03/Dutch-Technology-Pact-Summary.pdf, Last visited on 25.03.2019

people. This intelligent promotion includes the use of the appropriate terminology when describing work in the sector. For example, Dutch stakeholders mention that the term 'steel worker' is often used to describe individuals that work in the sector. This term bears a negative connotation, making work in the sector sound very low-skill, poorly paid and dirty, which it no longer is. For this reason, they prefer to use the term 'employees' for all the different professionals that work in the sector.

7.3.6. Poland

The steel industry

Poland is the fifth largest steel producer in the EU and the 19th largest globally. Steel (or metallurgy as it is known in Poland) constitutes one of the top 10 largest industrial sectors in the country. Indeed, the basic materials industries as a whole – comprising manufacture of basic metals, manufacture of non-metallic minerals, mining and quarrying – command 4% of Poland's economic activity as measured in terms of gross value added, compared with 2% in the EU-15. The sector thus accounts for a high share of Poland's economy in comparison with EU-15 averages[457]. The value of Polish steel sector shipments in 2017 amounted to PLN 33.6 billion (EUR 7.89 billion), which accounted for nearly 3% of industrial production[458]. Following two years of declining sales, revenue growth in 2017 was 15%. However, despite healthy sales levels in the steel and steel products manufacturing sector, profit margins declined as costs, especially of materials and energy, were growing faster than the sales revenue.

In 2017, the steelworks operating within the Polish sector produced a total of 10.3 million tonnes of raw steel, which translates into a growth of almost 15% in production compared to 2016. The share of blast furnace/BOF (BF/BOF) steel was higher than that generated in the EAF process. In 2017, 5.7 million tonnes of BF/BOF steel (55%) and 4.6 million tonnes of EAF steel (45%) were produced. The production of EAF steel in relation to 2016 increased 19% and the production of BF/BOF steel was up 11%. Both BF/BOF and EAF installations at domestic steelworks are modern and meet the BAT requirements[459].

Poland's steel production is a mix of domestic and foreign-owned companies and is concentrated amongst a handful of producers. The global company, ArcelorMittal, accounts for 70% of Poland's steelmaking capacity, producing 7.76 million tonnes of steel in 2017[460].The Polish subsidiary manufactures both flat and long products. It is one of the largest Polish exporters (and producers of coke) in both Europe and the entire ArcelorMittal Group. Celsa is the second largest producer (manufacturing bars, sections and castings), followed by CMC Poland (manufacturing billets, bars, wire rod and sections) and then Cognor SA (manufacturer of flat and long products, semi-finished). Along the value chain, between mills and final consumers of steel (e.g. the construction, automotive and household appliance sectors), there are a variety of specialised manufacturers and distributors in the sector, which process steel and metal goods for final use.

In addition to raw steel, the Polish steel industry also manufactures a significant amount of hot rolled steel products. In 2017, the production of such products totalled 8.8 million tonnes and grew by 9.6%. Over 60% of these were long products (5.3 million tonnes) and almost 40% of them were flat products (3.5 million tonnes). The former group was dominated by the production of rods, which totalled 2.5 million tonnes.

In 2017, the export of steel products from Poland amounted to 6.0 million tonnes, up 15% from 2016. Export sales accounted for approximately half the value of steel shipments at PLN 17.1 billion (EUR 4.01 billion). Exports to EU countries accounted for 89% of Polish total exports and increased 12% compared to the previous year. The major buyers of steel products from Poland were the Czech Republic, Germany, and Italy (totalling 58% of exports). Exports to third countries in 2017 increased 16% with the key buyers being

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[457] Bogdan, W., Boniecki, D., Labaye, E., Marciniak, T., Nowacki, M., *Poland 2025: Europe's New Growth Engine*, McKinsey & Company, Boston, 2015

[458] Hutnicza Izba Przemysłowo-Handlowa (HPIH), *Polish Steel Industry 2018, Annual Report,* HPIH, Warsaw, 2018

[459] Remus, R., Aguado Monsonet, M., Roudier, S., and Delgado Sancho, L., *JRC Reference Report: Best Available Techniques (BAT) Reference Document for Iron and Steel Production*, Industrial Emissions Directive 2010/75/EU (Integrated Pollution Prevention and Control) Luxembourg: Publications Office of the European Union, 2013

[460] Global Steel Trade Monitor, *Steel Exports Report: Poland*, May 2018

Russia, Turkey, and Ukraine (the share of these three countries in exports outside the EU was 62%).

Steel imports in 2017 amounted to 10.3 million tonnes, up 6% as compared to 2016. Imports from EU countries increased by 11% and their share in total imports increased to 82%. Imports from third countries increased by 1% in comparison to 2016. The third countries block saw the largest imports increase recorded from India, Moldova, and Turkey. The highest volume of imports was from India, Russia, and Ukraine (these countries accounted for 67% of imports from third countries). Overall, import growth exceeded the value of sales and amounted to PLN 33.7 billion (EUR 7.91 billion). The negative trade balance (PLN -16.6 billion = EUR 3.90 billion) worsened by as much as PLN 2.5 billion (EUR 587 million) and was the highest in history[461].

Current trends in the sector may be categorised as those both potentially posing a threat to the industry and as those constituting more positive opportunities. In terms of possible threats to the Polish sector, the following issues can be identified. First, at the global level, growing foreign trade tensions between major economies (namely the US and China), carry the potential risk of a trade war. This may harm future economic growth and the global steel market. Increasing protectionism of domestic steel sectors, such as in Brazil and India, has also been a trend in recent years[462].

Second, a major challenge for the global steel sector is the issue of excess production capacities amounting to 760 million tonnes. This brings down the utilisation rate of existing capacity to just 69% (HPIH, 2018: see also European Commission, 2013). The rising cost of raw materials, including iron ore and coking coal, coupled with high energy prices in the EU and Poland specifically, is another potential threat, as confirmed by workshop participants[463].

Related to the cost of energy, climate legislation and the need for resource efficiency emanating from the EU-level (e.g. the ETS and the Energy Efficiency Directive) is another important issue impacting the Polish sector. It is estimated that incremental innovations and the diffusion of BAT will provide for only a slight reduction in overall total direct energy consumption and CO2 emissions across the EU up to 2022, as many plants are operating at their thermodynamic limits. There is an urgent need for breakthrough technologies in steel production for CO2 emission abatement.

Third, EU policy concerning steel producers from third countries is still quite liberal (despite the imposition of some tariffs in 2017), meaning that the import of steel products mainly from India, Russia, and Ukraine remains high. Indeed, the Polish sector runs a trade deficit in terms of steel import and export. In 2017, the trade balance of the Polish steel industry was negative at -4.3 million tonnes and EUR -3.9 billion respectively. Moreover, in 2017, there was a significant growth in imports from other EU countries (+11%). Thus, while the import of steel products increased by 6% and stood at 10.3 million tonnes in 2017, Polish steel industry exports were 6 million tonnes (although this was an increase of 15% compared to 2016). Overall, despite the increase in consumption of steel products in Poland in 2017, foreign steel producers were still the main beneficiaries, accounting for as much as 71% of consumption of steel products in Poland.

Finally, to focus on personnel issues, the age structure in most European steel-producing companies is such that close to 30% will have left the industry between 2005 and 2025[464],

[461] Hutnicza Izba Przemysłowo-Handlowa (HPIH), *Polish Steel Industry 2018, Annual Report,* HPIH, Warsaw, 2018
[462] European Commission, "Action Plan for a Competitive and Sustainable Steel Industry in Europe", COM(2013) 407 final, European Commission, Brussels, 11.06.2013
[463] *Ibid.*
[464] *Ibid.*

and the Polish sector is no exception[465]. The industry thus needs to be able to attract production workers, as well as specialist scientific and managerial skills (see the section on skills needs for further discussion). However, the OECD identifies that both sets of skills are in short supply in Poland[466], with such shortages exacerbated by very high levels of emigration from the country following EU-accession. Skill shortage issues are confirmed by data from the workshop, with participants discussing the difficulties encountered recruiting workers with right sets of skills, which as will be detailed later in the report extend wider than those documented above. Moreover, unemployment in Poland is currently at an all-time low, and this also impacts the availability of labour (as well as rising wages in other economic sectors)[467].

The Polish Steel Association (HPIH) argues that enterprises in the steel sector had difficulties with recruiting employees as a result of record low unemployment and stagnating immigration, and thus, wage pressures[468]. Throughout 2017, wages and salaries grew moderately, but this accelerated in the last quarter.

Regarding more beneficial aspects, both currently and in future, global demand for steel continued to grow in 2017, attributable to the ongoing recovery in the economy throughout the world, both in terms of the acceleration of GDP growth in developed countries and the stabilisation of China's situation. Globally, increased investment spending and improvements in the raw material market also had a positive impact on steel demand. The consumption of steel products in the world reached 1.59 billion tonnes in 2017, up 2.9% as compared to the previous year[469]. Within the EU, the economic situation is currently good, with GDP indicators in 2017 at the highest levels in 10 years. GDP growth was positively impacted by internal and external demand, as well as by strong investment demand. The biggest improvement took place in the countries of Central Europe – including Poland – thanks to the inflow of EU funds. The Polish economy overall was developing at a rate of 4.6% in 2017, whilst the steel market in Poland increased for the fourth consecutive year (with consumption of steel products at a record 13.5 million tonnes).

On this point, the significant growth of infrastructure investments and major public investment projects, co-financed from EU funds, has boosted the Polish construction sector[470]. This industry currently consumes the largest proportion of steel products (e.g. for the construction of roads, buildings, pipelines and other steel structures). In 2017, the construction sector increased its production by 12% (after a 14% drop in 2016), consuming 5.7 million tonnes of steel i.e. over 43% of the total domestic consumption of this raw material. The magnitude of growth in infrastructure investments means that further increases in consumption of steel products were expected in 2018 (no data at the time of writing). Good performance figures were reported in other steel-using sectors such as metals products (the second-largest consumer of steel products), machinery and equipment, automotive, transport equipment, with these sectors experiencing good investment demand and export sales. The SWIP (Steel Weighted Industrial Production Index), linking the level of production activity in the steel consuming sectors with its domestic consumption, increased 9% in 2017, against a 1% decrease in 2016.

Despite the Polish sector's negative trade balance in 2017, exports increased by 15% over 2016 levels, which may be construed as a positive development. Moreover, the total consumption of finished steel products in Poland in 2017 amounted to 13.5 million tonnes, up 3% in 2016. The increase resulted from the sustained high levels of consumption in all

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[465] Cedefop, "Metal & machinery workers: skills opportunities and challenges", Skills Panorama 2019, See: https://skillspanorama.cedefop.europa.eu/en/analytical_highlights/metal-machinery-workers-skills-opportunities-and-challenges, Last visited on 05.06.2019

[466] OECD, "Skills for Jobs: Poland", 2019, See: https://www.oecdskillsforjobsdatabase.org/imbalances.php#PL/_/_/_/["skills"%2C"knowledge"%2C"abilities"]/co, Last visited on 05.06.2019

[467] Hutnicza Izba Przemysłowo-Handlowa (HPIH), *Polish Steel Industry 2018, Annual Report,* HPIH, Warsaw, 2018

[468] ArcelorMittal Poland, *Sustainability Report*, 2017

[469] HPIH, 2018, op. cit.

[470] *Ibid.*

quarters of 2017 and of the increase in the consumption of pipes and long products. There is thus scope for meeting increased domestic demand in the growing economy.

According to workshop participants, the sector requires better support from the national government and continued and more timely support from the European Union. The required measures detailed include changes in the legal framework at the EU level, especially in relation to customs, as well as financial support for costly activities undertaken by companies that put them at a disadvantage in comparison with competitors outside the EU, particularly measures required for the green transition. On the latter, workshop participants argued that the sector would benefit from a long-term strategy that would reconcile the requirement for continued investment in environmental protection with the need to maintain employment stability and profitability of the industry.

Finally, the sector has made good productivity gains over the last year, standing at over 3%. In turn, this increase in productivity fuelled improved investment spending, especially from foreign funds[471].

The image of careers in the steel sector

To contextualise the following, it should be noted that at the end of 2017, the Polish steel sector employed a total of 25,500 workers[472]. Due to the increase in production output in that year, employment in steel-making enterprises grew by approximately 2.5%.

Regarding perceptions of such employment within the sector, the growth rate of gross salary per employee in 2017 within the steel sector remained at a similar level to the previous year i.e. at approximately 4% (in contrast to growth from 3% to 5.5% across the manufacturing industry as a whole). Wages and salaries in the metallurgy sector are on average 15% higher than the industry average, but 20% lower than the average pay level across the entire economy. As regards industry average pay, the steel sector is arguably a relatively well-paid sector, which may prove a pull for some potential candidates[473].

Concerning biases and negative perceptions that might prevent people from wanting to work in the sector, it was reported by one expert interviewee that the sector is seen as one that is contracting, and thus, an industry of the past. According to workshop participants the image of the steel sector in Poland is far worse than desired due to lack of accurate information (e.g. on health and safety) and positive media messaging, non-competitive salary levels and lack of employment stability. For example, the workshop participants mentioned the recent case of a temporary shutdown of the blast furnace in ArcelorMittal steelworks in Kraków, which received wide media coverage. However, as noted above, wages in the sector tend to be higher than average for industry, relatively well-paid and thus competitive on some measures, which runs counter to wider perceptions (including to some extent those held by workshop participants). Further, as workshop participants note, great progress has been made on health and safety – it is no longer the case that the industry is a highly dangerous place of employment.

Such issues could potentially be addressed by the industry itself generating positive messages, making use of ambassadors and organising activities for the local communities where steel production sites operate. The service sector has, however, been identified as the main future growth area in the country[474]. Further, perceptions over risks to safety and the industry's impact on the environment also help create a negative view. Another interviewee stated that "there is a strong need to change the image of jobs in the sector ... jobs in the steel sector are not attractive for younger people, particularly for those who

[471] *Ibid.*
[472] *Ibid.*
[473] *Ibid.*
[474] Cedefop, "Metal & machinery workers: skills opportunities and challenges", Skills Panorama, 2019, See: https://skillspanorama.cedefop.europa.eu/en/analytical_highlights/metal-machinery-workers-skills-opportunities-and-challenges, Last visited on 05.06.2019

have degrees"[475] He went on to say that it is now much easier than in the past to get a degree in Poland (see below regarding the rapid expansion of HE) and that many graduates "do not want to perform manual labour, or what they think is manual labour. Rather, they want to be lawyers, white collar employees"[476]. One issue here is graduate perceptions on what constitutes a 'graduate job' and thus expectations of the graduate premium, which the steel industry might not be viewed to match, according to workshop participants).

To focus on the practices of the largest steel-producing company in the sector, ArcelorMittal Poland is aware of such barriers and in efforts to try to change perceptions, is a regular participant at a number of job fairs. These include the Engineering and Entrepreneurship Job Fairs at the Silesian University of Technology, Gliwice; those held at the AGH University of Technology, Krakow; as well as Absolvent Talent Days and AISEC career days at Katowice. It obviously does so to attract talent, but also to change perceptions of careers within the steel industry. To this end, it works closely with secondary schools and universities, holding open days and attempting to encourage young people into the sector. It also runs the 'ZainSTALuj się' scholarship and training programme for students, who are considering working in the steel industry.

Similarly, one expert interviewee, who works at a senior level in the steel-producer PGO, reported that his firm also works closely with local high schools and education providers, in efforts to change perceptions about the industry and overcome recruitment gaps. Such cooperation was identified as being of "paramount importance". The firm also offers internships, as part of this drive[477]. Workshop participants were also of the view that internships could be more widely used and, in addition, raised the notion of 'embassies' and 'ambassadors' to encourage young people to work in their local plants by organising meetings with students, parents and other community representatives. Other suggestions at the workshop focused on making better use of social media (e.g. vlogs) to show the industry at its best and in ways that connect to potential young recruits of the future.

An expert interview said that the firm now focuses much more on "communication and branding of steel careers", something which is "absolutely essential". He said that PGO has a team within their HR department that is dedicated for this purpose, reporting that the recruitment process has been:

> *"fully professionalised; whereas in the past there were only one or two people in charge for all topics, there are now different teams, each devoted to a specific process/topic, covering the whole spectrum, from communication and branding to the actual recruitment"*[478].

Skills needs

The Polish steel sector is confronted with several challenges, which it must overcome (e.g. deregulation, intensified competition, need for innovation, environmental sustainability, etc). Such processes of adaptation can only be achieved with a competent and adequately skilled workforce, aware of and prepared to face new challenges. However, an evaluation of a number of different sources (e.g. academic papers, national policy roadmaps, specialised statistical reports) indicates that the Polish sector faces both skill shortages in the external labour market and an internal generation gap within its own ageing workforce. With regard to the external labour market, the skills-needs of the sector can be attributed to a number of factors:

1. A general shortage of skilled technical and manual labour across the Polish economy, driven by deficiencies in the Polish VET system and PES training system, as well as by high emigration

[475] Interview notes - Industry Stakeholders, Senior-level representative at PGO
[476] Interview notes - Industry Stakeholders, Senior-level representative at PGO
[477] Interview notes - Industry Stakeholders, Senior-level representative at PGO
[478] Interview notes - Industry Stakeholders, Senior-level representative at PGO

2. The problems detailed above are worsened by the 'generation gap' in the sectoral workforce, which was itself created by recruitment freezes following industry restructuring in the light of intensified competition – according to workshop participants a related generational aspect is the reluctance of older worker to engage with new technologies and develop their skill profiles
3. The core skills (including soft skills) required to work in the sector can be said to have evolved over time and the requirement for such skills will become ever more pressing in the years to come. There is a clear and urgent need for human capital investment to consolidate industry skill profiles.

Given the nature of work in steel production, the occupational groupings and associated skills that are required by the industry come under the auspices of science, engineering and technical (e.g. metallurgists, energy specialists, production engineers, automation experts, developers and investment project managers), as well as skilled manual workers. For the steel sector specifically, ArcelorMittal Poland – the largest steel producer in the country with over 11,000 employees – states that steel companies and industrial firms generally are confronted with a huge employee deficit. The deficit areas include both engineers and specialists (in the scope of operating, servicing and repairing modern equipment and production areas), as well as automation engineers, specialists in electronics, energy, mechanics, locksmiths, train drivers, tool settlers, machine operators and turners[479]. The much vaunted 'digital skills' seem less in demand than anticipated according to the survey, which was an unexpected finding for workshop participants.

Similarly, one of the expert interviewees, who is employed by a large steel producing firm, identified that his firm is confronted with skills shortages within specialised roles for forging and melting, as well as metal workers generally, and laboratory technicians. He said that there is a "huge gap in Poland". Whilst it is relatively easy to find operators, it is very difficult to find people with specific professional skills such as melting or forging). One workshop participant raised the idea of scholarships to address skills shortages and attract high quality candidates.

Generally, across the Polish economy, there are skills shortages – every third employer reports such scarcities. Reported skills shortages are highest in the manufacturing, industrial, mining, construction, and transport sectors. Of most salience here are the reported shortages of both science and engineering professionals and skilled manual workers[480]. The workshop participants reported, moreover, a need for:

- English language skills;
- IT skills;
- Skills for interacting with machinery and making practical use of calculations;
- Environmental protection skills;
- Cultural awareness (in recognition of globalisation and the internationalisation of the industry);
- Multitasking and flexibility;
- Lifelong Learning.

It is not necessarily the case that all such skills and attributes listed here are in short supply, but what is evident is the need to look beyond the narrow emphasis on technical skills (often to meet immediate production needs) and focus on generic and soft skills too, including encouraging continuous professional development (CPD) or Lifelong Learning (LLL).

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[479] ArcelorMittal Poland, *Sustainability Report*, 2017

[480] Cedefop, "Poland: Mismatch priority occupations", Skills Panorama, 2016, See: https://skillspanorama.cedefop.europa.eu/en/analytical_highlights/poland-mismatch-priority-occupations, Last visited on 05.06.2019

For metals and machinery workers in general (not just those employed in the steel sector, but across all sectors of the Polish economy), employment is projected to change by -3.14% in the period 2016-2030, as compared to -12.90% across the EU. With regard to future job openings for metal and machinery workers in Poland over the same period, Cedefop predicts that there will be 297,700 such opportunities[481]. New/lost jobs have a value of -21,728 but replacement demand (i.e. the need to replace workers leaving a profession for various reasons, such as retirement) stands at 319,449. The main cause for employment within the Polish steel industry in future is the retirement of a future workforce as opposed to sectoral expansion. It means that these occupations and associated skillsets will continue to be in demand across the economy, which means a competitive labour market for the steel industry in the future. One expert interviewed during the compilation of this report confirmed this:

> *"In the coming years, there will be a growing demand for new manual and technical workers due to the nuisance [sic] of metallurgical professions and the possibility of early retirement. In particular, this will apply to employees employed in key positions in the technological process"*[482].

With regard to science and engineering professionals, problems of filling job vacancies are persistent for engineers, with the highest demand related to the optimisation of manufacturing processes. In this area, skills shortages result from three factors.

The first is the low quality of education. According to employers, one of the main reasons for the difficulties in finding candidates for engineering positions is the lack of appropriate technical skills, which concerns more than 50% of candidates. As stated by an expert interviewee, 80% of steel industry employers "indicate difficulties in finding a suitably prepared employee for existing or planned (new) positions"[483]. The workshop recommended the reintroduction of dual education, which would integrate trainees/apprentices within the industry and facilitate greater preparedness. Such programmes should be more comprehensive, increased in length and be more specific, according to workshop participants – specificity, might, however frustrate development of the flexibility and multitask skills that the same participants also stated as skill needs. The workshop also suggested use of internships to better integrate students to industry practices.

A second reason is the mismatch between education and the needs of employers located in a given region. This is mainly due to the lack of coordination between universities, vocational colleges and labour market institutions in preparing the educational programmes, as well as the lack of liaison with/input from employers about the occupations and skills required. According to workshop participants this situation is exacerbated by the lack of up-to-date and practical knowledge of the industry held by teaching staff and school and university staff such should therefore be provided with an opportunity to gain practical experience, as well as apprentices/trainees.

Finally, emigration from Poland is a significant factor, especially in the case of young people. The evidence suggests that young engineers usually decide to leave permanently and settle in another country, as opposed to engaging in temporary migration[484]. Wider developments, such as Brexit and a more prosperous economy in Poland, are beginning to slow and reverse this trend.

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[481] Cedefop, "Metal & machinery workers: skills opportunities and challenges", Skills Panorama, 2019, See: https://skillspanorama.cedefop.europa.eu/en/analytical_highlights/metal-machinery-workers-skills-opportunities-and-challenges, Last visited on 05.06.2019

[482] Interview notes - Industry Stakeholders, Senior representative at the Instytut Metalurgii Żelaza im. St. Staszica

[483] Interview notes - Industry Stakeholders, Senior representative at the Instytut Metalurgii Żelaza im. St. Staszica

[484] Cedefop, 2016, op. cit.

Counteracting the shortage of engineers is a government priority. Until 2014, this policy goal was enacted through 'Ordered Programmes', which aimed to increase young people's interest in studying science and engineering. This programme was assessed as moderately effective, as only approximately 50% of graduates took up employment in occupations consistent with qualifications gained during their studies. In 2014, 'Ordered Programmes' were replaced by a 'Skills Development Programme', comprised of measures aimed at those in HE, rather than having a pre-entry focus. It provides for the strengthening of entrepreneurship education, professional competence, interpersonal and analytical skills. The Ministry of Science and Higher Education orders and finances training for selected competencies in all fields of study within the programme. The programme focuses on workshops, use of new technologies in HE and the promotion of modular education and interdisciplinary studies. These activities are financed under the Knowledge, Education and Development Operational Programme (POWER).

Measures targeting skills of existing employees are mainly limited to the Registry of Developmental Services, and the National Training Fund. However, extant programmes aimed at eliminating shortages of engineers have not proved effective against emigration. Within the programme of voluntary return and reintegration, an information portal has been introduced for people planning to return to the country. Another measure relates to the implementation of temporary residence permits for overseas workers, allowing them to work in highly qualified jobs. However, there is no systematic solution designed to reverse the current trend, e.g. by pursuing a specific immigration policy.

Filling vacancies for skilled manual workers has been a problem in Poland for many years. Welders, fitters, turners, forklift operators, mechanics and electricians are the occupational groups most in demand. The major causes for these skills shortages in skilled manual work have been identified as deficiencies in the VET system and the system of crafts and training provided by PESs. The high emigration rates, particularly of young people and highly skilled workers to northern and western Europe, is another factor[485].

To begin with the shortcomings of the Polish VET system, the number of students attending vocational schools across Poland has fallen dramatically since educational reforms enacted nationally in the 1990s, in 1998 particularly. The reforms were aimed at increasing the proportion of students in general high school education to 80% with a concomitant reduction of the proportion of students in vocational education at post- middle school level to 20% (i.e. a reduction of more than half in the proportion of students at vocational schools compared to before the reform). The other aim was to achieve a six-fold increase in the gross enrolment ratio in HE (from 11% in 1990 to 65% in 2010) [486].

These changes had very important consequences for vocational education, which became almost completely insignificant as the proportion of students attending basic vocational and technical schools fell from 53% to 20%[487]. This marginalisation of vocational education not only caused a precipitous drop in interest in these types of schools amongst potential students, but also among the employers who worked with these schools to recruit prospective employees. This led to an overall reduction in the quality of education provided by vocational schools, and a parallel reduction in the employability of graduates representing different occupations[488].

Another significant factor which lowered the prestige of vocational education was the fact that a large number of new HE institutions opened during this period in Poland, while at the same time, there was a reduction in the entrance requirements at high schools and universities. Between 1990 and 2010, the number of students in HE in Poland rose by 370%. This growth occurred mainly among students in social sciences and humanities at

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[485] *Ibid.*
[486] NESsT, *Closing the Skills Gap in Poland*, Warsaw, 2017
[487] *Ibid.*
[488] OECD, *Education Policy Outlook: Poland*, Paris, 2015

privately funded universities[489]. At the same time, the numbers of students enrolling in STEM courses fell, mainly due to education policy between the 1980s and 2010, which for example, did not require that mathematics be a compulsory element in the attainment of a high school diploma. The quality of HE at the new universities was not particularly high, as the focus was on high enrolment rates.

The main consequence of these processes is the growing imbalance between labour market supply and demand in recent years[490]. There is an increasing oversupply in some occupations, whilst at the same time, labour trends show that there is still strong employer demand for people trained in certain vocational skills that have been de-emphasised. The educational reforms of the 1990s have been widely criticised for not matching the needs of the labour market, which has in turn resulted in unemployment and underemployment of young people on the supply side and a talent gap and lack of skilled labour among many industries and sectors on the demand side[491]. The major steel companies continuously call for a coordinated and sophisticated policy response to improve the VET system. As stated by one interviewee:

> "*The educational offer in Poland is not adapted to industry's requirements, including the requirements of the steel industry. Vocational education and training in Poland require reconstruction*"[492].

There have been some policy responses aimed at strengthening the VET system, introduced in 2012/13 (to have been fully implemented by 2017). There have been efforts to reform curricula, the national qualifications framework has been modernised and there have been efforts to strengthen links between the VET system and employers in ways called for workshop participants (i.e. towards dual education). However, the OECD reports that the VET system still does not seem well-aligned to labour market needs, with major challenges in fostering enhanced cooperation between enterprises and VET schools[493]. Two general strategies, the *Strategy for the Development of Human Capital 2020* (2013) and the *Lifelong Learning Perspective* (2011), aim to further tie the education system to labour markets.

In addition, the Minister of National Education defined the academic year 2014/15 as the Year of VET Professionals (Rok Szkoły zawodowców). This is linked to a set of continuing initiatives that will be financed from the state budget and EU Structural Funds. The main features of the programme include the promotion of VET through strategic media communication campaigns to change the perception of VET as "second choice" education; the fostering of collaboration between employers and the Ministry of Education to increase the number of professional opportunities and adjusting provision of skills to the needs of the labour market; funding for employers to cover the cost of vocational programmes for youth; and the signing of the Four-Party Agreement between the Ministries of Economy, Education, Treasury and Labour to promote VET and provide support, including measures for employers engaged in VET in special economy zones[494].

As identified across a range of literatures, the "generation gap" is becoming an increasingly pressing issue for the Polish steel industry[495] [496]. The generation gap is the term used to describe the imbalances in the age profile of steel plants' workforces with low numbers of

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[489] Ministry of Science and Higher Education, *Reforma systemu edukacji: szkolnictwo ponadgimnazjalne*, Ministry of National Education, Warsaw, 2013
[490] OECD, *Education Policy Outlook: Poland*, Paris, 2015
[491] NESsT, *Closing the Skills Gap in Poland*, Warsaw, 2017
[492] Interview notes - Industry Stakeholders, Senior representative at the Instytut Metalurgii Żelaza im. St. Staszica
[493] OECD, "Skills for Jobs: Poland", 2019, See: https://www.oecdskillsforjobsdatabase.org/imbalances.php#PL/_/_/_/["skills"%2C"knowledge"%2C"abilities"]/co, Last visited on 05.06.2019
[494] OECD, 2015, op. cit.
[495] ArcelorMittal Poland, *Sustainability Report*, 2017
[496] Gajdzik, B. & Szymszal, J., "Generation Gap Management in Restructured Metallurgical Enterprises in Poland", in *International Journal of Management and Economics*, 47: 107–120, 2015

young workers whilst those aged 50 and above are high. For example, ArcelorMittal Poland states most of its workforce is over the age of 50 and that more than 30% are over the age of 55 (Gajdzik and Szymszal put the figure at 50%[497]). It has stated that, out of 672 employees who left the company in 2017, 443 (or 66%) were more than 51 years old. Thus, the pending retirement of a large proportion of the workforce threatens Polish steel companies with huge loss of expertise. Workshop participants are of the view that this issue should be tackled by the introduction of an adequate knowledge transfer processes within companies, supported by the dual education system (as called for above). In view of this, workshop participants identified that mentorship programmes within companies should be strengthened and formalised to tackle the generation gap and support the transfer of knowledge from retiring workers to younger ones.

The generation gap has been caused by structural changes within the sector, where a decrease in steel output led to sharp decline in employment. New hiring was limited as part of a strategy of employment rationalisation and eventually, a generation gap emerged[498]. This is particularly acute given overall labour shortages in the Polish economy and specifically for skilled manual workers, engineering, technical and scientific professionals. It is further exacerbated by demographic shifts manifested in an ageing population in Poland, and negative perceptions of the sector, its working conditions – views that are proving to be repellent for potential applicants.

Finally, with regard to the underpinning core skills necessary to undertake jobs in the sector, Cedefop identifies job-specific skills, problem solving, teamwork, learning and communication[499]. The experts interviewed identified a broader range of core skills, including soft skills and those necessary for adaptation to a changing workplace. One interviewee identified the continued need for "physical predispositions, such as strength, fitness and endurance" as well as an ability to engage with continuous professional development – "employees need the ability to systematically improve professional qualifications; this is necessary in the era of rapid technological progress"[500]. He went on to say that mathematical and analytical skills are required and that such skills will grow in importance. With regard to the digitalisation of industry, he stated that the knowledge of techniques of using the Internet and modern information technologies are vital: "One should expect a demand for new skills related to the support of professional computer systems used to manage and control the production and quality of steel products"[501].

Similarly, another interviewee said that he believes that there will be a greater focus on Industry 4.0 and on automation in five years from now. Moreover, in the longer term, he believes there will be a need for more technical profiles and people who can work with robotics. However, he said that in the short-term (five years on), expectations and needs will be much the same as processes in the industry are slow to change[502].

Another interviewee spoke of the need for employees to not only understand modern technological processes and combine and apply interdisciplinary knowledge, but also identified the need for analytical skills and the appropriate use of software for data and statistical analysis, a clear reference to the need for IT and digital skills. As for soft skills, he identified 'elasticity of thought and broader thinking in combining facts; the ability to adopt a multi-criterial approach to problem-solving.' Finally, he spoke of the need for employees to have teamworking (multicultural) and good communication (linguistic) skills, as well as the ability to adjust. On this point, as with the other interviewee, he spoke of

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[497] *Ibid.*
[498] *Ibid.*
[499] Cedefop, "Metal & machinery workers: skills opportunities and challenges", Skills Panorama, 2019, See: https://skillspanorama.cedefop.europa.eu/en/analytical_highlights/metal-machinery-workers-skills-opportunities-and-challenges, Last visited on 05.06.2019
[500] Interview notes - Industry Stakeholders, Senior representative at the Instytut Metalurgii Żelaza im. St. Staszica
[501] Interview notes - Industry Stakeholders, Senior representative at the Instytut Metalurgii Żelaza im. St. Staszica
[502] Interview notes - Education Providers, Associate professor at the Silesian University of Technology

the need for employees to engage in continuous professional development so as to be able to adjust to changing circumstances[503].

Measures for up-/reskilling employees in the steel industry

The educational programme for the Polish steel industry includes both HE and VET, with both systems providing engineering and technical qualification routes (although one expert interviewee explicitly states that the "country's educational offer is not adapted to industry's requirements, including the requirements of the steel industry"[504].

There are a number of national HE providers/universities, which offer courses related to steel and non-ferrous metals. These are the:

- AGH University of Science and Technology, Krakow which focuses on:
  - Recycling and metallurgy
  - Metallurgy
  - Engineering of cast processes
  - Materials engineering
- The Warsaw University of Science and Technology, Warsaw, which focuses on:
  - Materials engineering
  - Automation and robotisation of production processes
- The Wrocław University of Science and Technology, Wrocław, which focuses on:
  - Industrial informatics
- The Silesian University of Technology, Gliwice, which focuses on:
  - Numerous dual studies schemes (up to doctoral level, although at early implementation stage) with relation to some steelworks and industrial partners (e.g. Wielton S.A.)
- The Czestochowa University of Technology, Częstochowa, which focuses on:
  - Materials engineering,
  - Metallurgy and metal technology
  - Plastic processing and security engineering production management

On the subject of dual schemes i.e. combining theoretical input at an educational institution with more practical workplace experience, a number of larger steel companies offer particular schemes. As mentioned above, workshop participants would like to see a more comprehensive introduction of dual education. ArcelorMittal Poland runs 'ZainSTALuj się' – this is a scholarlship and training programme for students, who would like to enter the steel industry. The scheme is offered at three sites: Krakow, Dabrowa Gornicza and Bytom. CMC Poland Sp. Z o. o. (Zawiercie) and Pokój S.A. Steelworks offer scholarships and training for students, whilst Celsa Steelworks at its Ostrowiec Świętokrzyski plant, runs its 'ElektroStart' programme, which provides three months training for electronics graduates.

In addition to the traditional mechanics and electronics apprenticeships offered by the Polish VET system, there are a number of vocational schools focusing specifically on steelmaking, welding, etc. These are located variously at Krakow, Konin, Czestochowa and Szczecin. There are two vocational qualification courses that are focused specifically on the steel sector, these being SIMPTESTCERT and TUV NORD Polska[505]. As regards other national practices, steel employers may request the provision of specialist training of employees at regional Lifelong Learning Centres (CKU). Employers would fund such

[503] Interview notes - Education Providers, Associate professor at the Silesian University of Technology
[504] Interview notes - Education Providers, Associate professor at the Silesian University of Technology
[505] Interview notes - Education Providers, Associate professor at the Silesian University of Technology

training, but using EU structural funds, CKUs may provide such development activity on their own initiative.

Another national programme that will provide funding to help develop digital skills amongst the sector's workforce (as well as digitalisation of industry in general) is the Future Industry Platform[506]. This was announced as part of the Responsible Development Plan (the 'Morawiecki Plan') by the Ministry of Finance and Development in 2016 and was launched in 2018. Financing is to be provided over a 25-year period, with EU funding used for the implementation phase and market transformation. The main mission of the platform is to act as an integrator of all stakeholders interested in Industry 4.0, as well as an accelerator of the digital transformation of the Polish industry. The platform seeks to achieve these goals through a mix of activities comprising knowledge transfer and awareness raising, as well as the development and application of digital transformation support measures. Education and training will be part of the programme, and a network of Industry 4.0 competence centres is to be established.

To focus on the national policies aimed at improving the educational offer of relevant skills for the steel industry, the "Skills Development Programme", comprised of measures aimed at those studying engineering in HE, and focusing on the development of entrepreneurship, interdisciplinary thinking, professional competence, and interpersonal and analytical skills, has been discussed above. With regard to the Polish VET system, its weaknesses have already been outlined. There have been national policies aimed at remedying the deficiencies in the VET system, with most reforms initiated in 2012 and to be fully in place by 2017. These include efforts to reform curricula; the national qualifications framework has been modernised, and there have been efforts to strengthen links between the VET system and employers – according to workshop participants this should include workplace participation/visits by educators from schools and universities. Two general strategies, the Strategy for the Development of Human Capital 2020 (2013) and the Lifelong Learning Perspective (2011), aim to further tie the education system to labour markets. In 2015, further reforms – to be financed via the state budget and EU Structural Funds – were introduced. These include the promotion of VET through strategic media communication campaigns to change the perception of VET as "second choice" education; the fostering of collaboration between employers and the Ministry of Education to increase the number of professional opportunities and to adjust provision of skills to the labour market needs; funding for employers to cover the cost of vocational programmes for youth[507]. As the reforms have only recently been fully implemented, it is too early to attempt to evaluate the outcomes.

One of the experts interviewed in the compilation of this report calls for further reforms of the VET system (as do the largest steel companies). He believes that the dual system, "based on parallel vocational school education (theoretical knowledge) and practical training at the workplace (direct contact with the company)"[508] is best practice and that "this should be the model used across both VET and HE programmes"[509] – a view confirmed by workshop participants. This would have the benefit of ensuring that "training is strictly adapted to the expectations and needs of employers and allowing students to smoothly transition from school to active working life".

He further emphasised the need to strengthen the relationship between education and employment, calling for systematic research into employers' needs for skills, qualifications and numbers of relevant occupations. The inclusion of employers in permanent cooperation structures focused on adjusting vocational education to the needs of the labour market is key. An increase in the use of modernised content, tools and resources supporting the

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[506] European Commission, Digital Transformation Monitor, *Poland: "Initiative for the Polish Industry 4.0 - The Future Industry Platform*, 2018

[507] OECD, *Education Policy Outlook: Poland*, Paris, 2015

[508] Interview notes - Industry Stakeholders, Senior representative at the Instytut Metalurgii Żelaza im. St. Staszica

[509] Interview notes - Industry Stakeholders, Senior representative at the Instytut Metalurgii Żelaza im. St. Staszica

vocational education process with enhanced emphasis on organisational solutions in the field of cooperation between vocational education and HE (i.e. the voice of the employer should have stronger influence) is required. There should also be provision for feedback to the vocational education system on the fate of vocational school leavers. Ultimately, he believes that business should establish their own vocational schools, so as to ensure that the needs of industry are met. Until this time, employers must engage with and: "participate in the elaboration of education programs in public schools provide apprenticeships to students of these schools, linking them with their own system of funded scholarships"[510].

On this subject, another of the interviewees reported that this is beginning to happen in practice:

> *"There are more and more discussions and questions between the education providers and the industry: schools and universities are asking more and more what the industry needs in order to align their programmes"*[511].

The expert interviewees stated their belief that regional initiatives are best placed to enhance the educational programme. An example of an effective regional programme, which sought to reform technical VET was provided. This took place in the province of Silesia, which has had particularly acute problems with the decline of VET[512]. Whilst the numbers of students attending vocational schools has fallen dramatically across Poland since the educational reforms of the 1990s, the decrease has been even more acute in Silesia. The numbers here have declined by 77% since the end of the 1990s (from 16,064 to 4,111).

In Lower Silesia, between 2009 and 2015, a reform project entitled "Modernisation of vocational training centres in Lower Silesia" was implemented. In the first phase, the project encompassed the adjustment of vocational education to meet the needs of the regional labour market while equipping graduates of vocational schools with competences expected by employers in key industries for the region. In the second part of the project, the vocational education system in Lower Silesia was modernised through the creation of educational centres equipped with modern specialist equipment to conduct didactic activities. Over 20,000 pieces of modern technological equipment were purchased (e.g. numeric machine tools with full software) to equip 415 vocational training rooms. This new equipped didactic base serves about 25,000 young people.

In Poland, a deregulated approach to training predominates[513]. This means that the principal responsibility for training rests with companies. Consequently, less formal, learner-centred and individualistic approaches to learning tend to be adopted. Thus, it is instructive to focus on company-level initiatives, and in particular, those of the largest steel-producing firm, given its status within the Polish sector. ArcelorMittal Poland has been publicly critical of the deficiencies in the VET system and has stated that "vocational and technical are few and far between and hence the burden of educating the youth. In particular, the practical aspects of steelmaking are on the steel producers"[514]. In a recent corporate publication, it highlights the 'challenges' presented by both demography and the Polish VET system. Workshop participants were also highly critical of training provision.

To address the vocational skills shortage, ArcelorMittal Poland says that it promotes dual education through apprenticeships and internships. Moreover, it is working closely with social partners, tightening cooperation with city authorities, and local secondary and vocational schools and universities of technology. It calls for complementary solutions from

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[510] Interview notes - Industry Stakeholders, Senior representative at the Instytut Metalurgii Żelaza im. St. Staszica
[511] Interview notes - Industry Stakeholders, Senior-level representative at PGO
[512] ArcelorMittal Poland, *Sustainability Report*, 2017
[513] Stroud, D. and Fairbrother, P. (2006) 'Workplace Learning: dilemmas for the European steel industry.' *Journal of Education and Work,* 19(5): 455-80.
[514] ArcelorMittal Poland, 2017, op. cit.

policy makers. It describes its training priorities as being the development of technical skills including industrial automation and programming, as well as education around new technologies. It also aims to cultivate more generic, soft skills across its workforce. ArcelorMittal Poland identifies them as decision-making skills, efficient problem solving and coaching/mentoring skills and analytical thinking. The company utilises a range of training and development methods. All employees have personal development plans. Each employee received an average of 27 hours of training in 2016. Via an annual Learning Week, the company encourages focus on continuous professional development and aims to raise awareness of the company's training programmes. The training and development methods utilised include on-the-job learning through participation in specialist project work and secondments, both within Polish sites and in ArcelorMittal sites overseas. Further, the company aims to cultivate intra- and inter-team mentoring, utilising the expertise of older workers as coaches for younger team members. Between 2015 and 2017, ArcelorMittal Poland ran a fourth series of its Talent Academy. This programme allows teams consisting of mentors (experienced employees who are experts in their fields) and young engineers (with below three years of experience) to work on improvements or finding solutions to a real problem, which facilitates the development of both technical and soft skills. In the fourth series, 29 young engineers worked with 21 older mentors[515].

[515] *Ibid.*

7.3.7. Spain

The steel industry and its competitiveness

Spanish steel in Europe

Spain is the fourth largest steel producer in Europe. It holds about 8.5% of the European steel market share, with an estimated 14.5 million tonnes produced in 2018[516]. The Spanish steelmaking industry's impact on the EU economy is shown in Figure 14. Spain is one of the six countries that together account for more than 60% of total European activity, only behind France, Germany, and Italy, historically known as great steel producers.

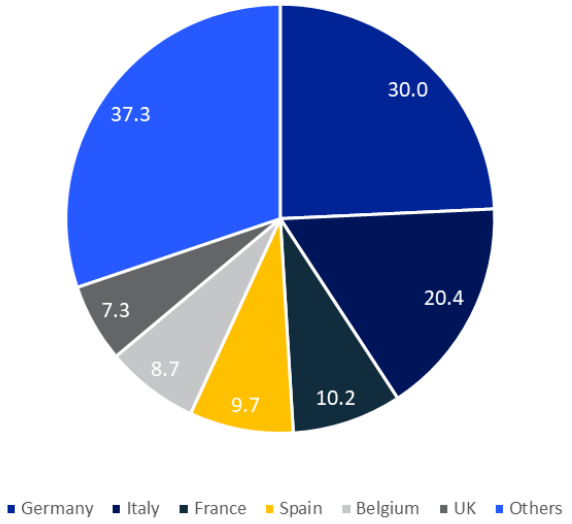

Figure 14 — Spain steelmaking industry's impact on the EU economy in EUR billions[517]

The industry's total contribution to European gross value added (the sum of the direct, indirect and induced impacts) was EUR 127.58 billion in 2016, associated with 2.47 million jobs. In Spain, the same contribution for the steel industry was EUR 10.41 billion of gross value added, associated with 235,000 jobs. The country's top steel producer remains ArcelorMittal, followed by Acerinox, Celsa and Sidenor as shown in the table below.

Table 24 — Spain's top steel producers in 2017[518]

Company	Production (million tonnes)	Main products
ArcelorMittal	7	Cold-rolled coil, hot-rolled coil, rails, wire rod
Acerinox Europa	2.5	Stainless flat products, stainless long products
Celsa Group	2.4	Bars, reinforcing bars, wire rod, structural sections
Sidenor	1	Bars, wire rod, ingots, billets
Tubacex SA	NA	Seamless tube, stainless long products, fittings

Domestic steel industry

Steel production is concentrated in about 20 sites, which are mainly located in Asturias and the Basque Country. The only two blast furnaces still functioning are located in Gijón

[516] EUROFER, *European Steel in Figures 2018*, 2018
[517] Oxford Economics, *The impact of the European steel industry on the EU economy*, May 2018
[518] US Department of Commerce, International Trade Administration, *Global Steel Trade Monitor - Spain*, May 2019, See https://www.trade.gov/steel/countries/pdfs/exports-Spain.pdf, Last visited on 03.06.2019

and they supply ArcelorMittal's steel plants in Gijón and Avilés. The rest of the steel production relies on EAFs. Transformation processes happen in a variety of facilities all across the country[519].

The 2008 financial crisis has weakened the financial and industrial viability of many steel companies considerably, resulting in massive sales of businesses and sites, debt refinancing, and above all, social adjustments and flexible working time arrangements. Often, industrial plans or investment projects have been subordinated to the adoption of these adjustments. Because of the crisis, employment in the steel sector in Spain fell by 17% between 2010 and 2016. The long products segment (representing two-thirds of national production) took the heaviest hit, with a fall in internal demand of 47% between 2008 and 2017. The fall in internal demand was partly toned down by the demand of foreign markets (in particular Algeria and North Africa). According to an interviewee from the Spanish Ministry of Industry, Trade and Tourism (Dirección General de Industria y de la PYME, Subdirección General de Políticas Sectoriales Industriales), stagnating steel production levels went hand in hand with little technological innovation. Few Spanish facilities have been upgraded, with little investment in innovation or new plants. The main focus of the Spanish industry is still maintaining stable production levels rather than increasing them[520].

Overall production in 2017 experienced an increase compared to the previous year, but production still remains far behind the level of 2008. This is mainly due to a decline in the manufacture of long products. From 1980 to 2019, steel production in Spain has averaged 1.2 million tonnes. Production levels reached an all-time high of 1.9 million tonnes in 2008 and an all-time low of 555,000 tonnes in 1988[521]. According to Trading Economics, steel production in Spain reached 1.17 million tonnes at the end of the third quarter of 2019.

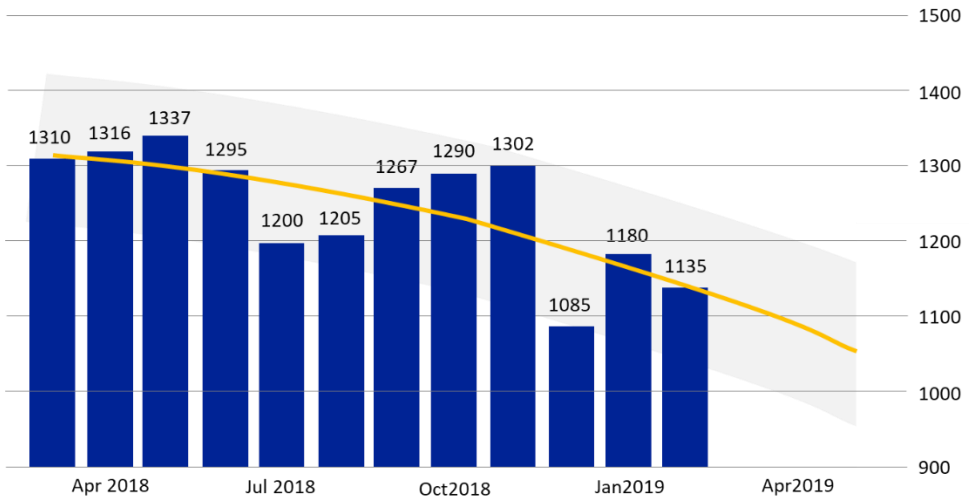

Figure 15 — Evolution of steel production in Spain with trend estimation[522]

Despite production still being well below pre-crisis levels at the beginning of 2019 (Figure 15 — Evolution of steel production in Spain with trend estimation), the steel industry is still an important sector in the Spanish economy, especially in those regions that are traditionally linked to steelmaking. Overall, the sector accounts for 18,600 jobs in the country, which corresponds to 5.5% of the total workforce in the European steelmaking industry[523]. These proportions are presented in Figure 16.

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[519] Syndex, *Fiche Pays - Espagne*, May 2018, Data provided by Syndex (https://www.syndex.eu/)
[520] Interview notes - Industry Stakeholders, Senior representative at UNESID
[521] Syndex, *Fiche Pays - Espagne*, May 2018, Data provided by Syndex (https://www.syndex.eu/)
[522] Trading Economics, Spain Steel Production,See: https://tradingeconomics.com/spain/steel-production, Last visited on 03.06.2019
[523] EUROFER, *European Steel in figures 2018*, 2018

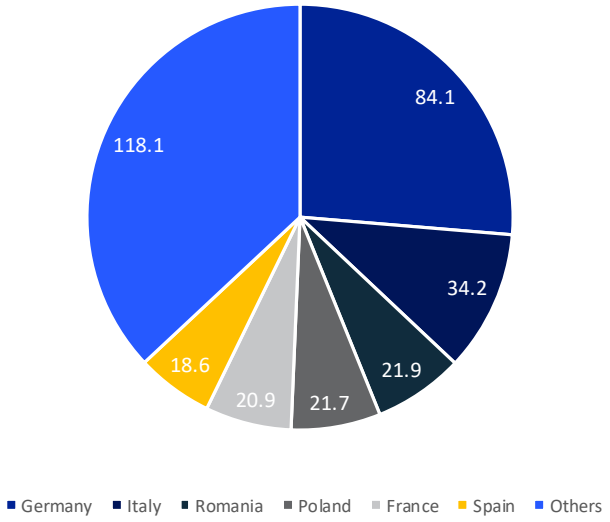

Figure 16 — Spain: steelmaking jobs in 2017 - '000[524]

Nowadays, there are indications that the steel industry is recovering, e.g. by the re-opening of industrial plants and investment projects aimed at ensuring the continuity of industrial activity and steadier employment levels. The investments in ArcelorMittal Asturias and the reopening of Thyssenkrupp in Sagunto at the end of 2016 show the overall good health of the flat products segment, which supplies the Spanish automotive industry.

However, a number of companies still face challenges on their path to recovery:

- In 2016 the Spanish steel group Celsa had to face negative results and a delicate renegotiation of its debt, which amounted to EUR 2.7 billion, resulting in wage cuts and cost reduction programmes
- CONDESA went through a difficult period after it closed its plants in Belgium and sold to ArcelorMittal all of its assets in Lorraine Tubes in France. Only three plants were kept by Condesa and still suffer a critical situation (Mieres Tubos in the Asturias, for instance, declared its liquidation in the first quarter of 2019)
- After its acquisition by Gerdau Aceros Europa in 2016, Sidenor underwent substantial changes, as a new sustainability plan was proposed including flexibility measures, geographic and temporal mobility, as well as a social plan for 2017-2018 with wage cuts of around 10%[525]

The case of ArcelorMittal

ArcelorMittal is the largest steel producer in Spain. With a workforce of 9,500 people, the company operates 12 sites, focusing on the production of flat and long products. Additionally, ArcelorMittal can count on 17 distribution centres across the country and 2 R&D centres. The company produces 7 million tonnes of crude steel, which amounts to 47.7% of Spain's total output[526].

ArcelorMittal operates the only integrated steel site in Spain, with two blast furnaces as well as an EAF mini mill for flat products. Flat product units mainly supply the automotive, packaging and household appliance industries, whereas the long products mills supply the construction and industry sectors.

In 2017, ArcelorMittal rearranged its assets[8], especially in the long products market:

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[524] Oxford Economics, *The impact of the European steel industry on the EU economy,* May 2018, p.51
[525] Syndex, *Fiche Pays - Espagne*, May 2018, Data provided by Syndex (https://www.syndex.eu/)
[526] ArcelorMittal, *Integrated Annual Review 2018*, 2019

- The Zaragoza plant was sold to the Spanish group Megasa, which specialises in long steel products for construction
- The Zumàrraga site was closed
- ArcelorMittal Sestao stopped production in 2015 because of low profit margins, which were linked to high energy costs and scrap prices. The site restarted in 2016 with a much smaller number of workers (140) and was profitable in 2017 with good prospects for 2018 thanks to the automotive market

In December 2017, ArcelorMittal confirmed its plan to invest more than EUR 200 million in its facilities. Out of this amount, nearly EUR 90 million have been invested in a 5-year environmental improvement plan. EUR 80 million were invested in the two sinter sites, the blast furnaces, the new batteries, the Aboño coal-fired plant and the Aboño coal park, while EUR 8 million was be dedicated to small-scale environmental investments. According to ArcelorMittal, the plan aims to reduce particulate emission by 70-80% and diffuse emissions by 50%[527]. Additional investments include EUR 130 million for the construction of new coke batteries in Gijón. These are expected to produce 1.1 million tonnes of coke, i.e. 300,000 tonnes less than the old ones, and require half the staff to be operated.

Industry outlook

Profit margins remained stable in the second semester of 2019. The direct impact of US import tariffs on the metals sector, including steel, is low given the limited share of exports to the US (about 5% of total Spanish steel exports). The risk of a decrease of prices in the steel market remains due to surplus exports from outside the EU, especially from Russia and Turkey. It seems that the additional safeguarding measures set up by the EU could be a strong mitigating factor.

The competitiveness of the domestic steel and metals industry in Spain remains adversely impacted by power costs, which are about 30% to 50% higher than in France and Germany. This is of paramount importance for the sector, given that 75% of Spanish steel producers work with EAFs. The ratings of the steel sector in Spain are at present cautious or even neutral due to the potential downside risks, e.g. escalation of trade disputes, Eurozone growth deceleration and decreasing demand from major buyer industries like automotive and construction.

Current and future skills needs

Labour market dynamics

After a decade spent facing an economic crisis, Spain has shown growth only in 2014. The unemployment rate is still well above the EU average, with a steep decline experienced during the period 2011-2016[528]. Spain seems to be on its way to recovery in the forthcoming years. Employment is expected to grow substantially until 2030, driven above all, by the services sectors in general and ICT services. For the period 2016-2030, employment growth in Spain is estimated at 9.9%, of which manufacturing accounts for 14.6%, and ICT services account for 25.8%. The biggest growth is foreseen for Wholesale and retail trade at 36%[529].

According to Cedefop's projections, 50% of total job vacancies until 2030 will need high qualification levels to upgrade the country capacity and increase its ranking in R&D&I. This includes the replacements for vacated jobs arising from retirement. Spain offers many job opportunities for people with low qualifications, but these will decrease radically in the forthcoming years, according to projections.

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[527] Syndex, *Fiche Pays - Espagne*, May 2018, Data provided by Syndex (https://www.syndex.eu/)
[528] Cedefop, Skills Panorama, https://skillspanorama.cedefop.europa.eu/en/countries/spain, Last accessed on 03.06.2019
[529] *Ibid.*

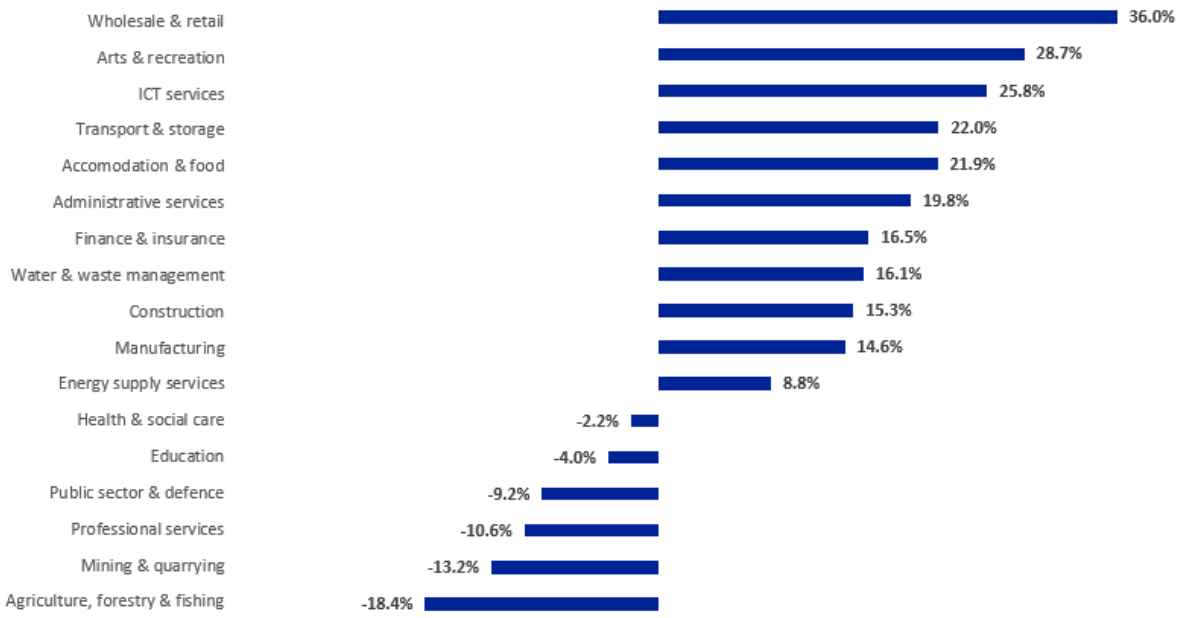

Figure 17 — Spain: Future employment growth (in%) across sectors (2016 - 2030)[530]

According to available data, the manufacturing sector is one the most important sectors in terms of employment share in 2017. In 2017, the largest share of employment in Spain was in wholesale and retail trade (15.75%), followed by manufacturing (12.77%), making the sector a very important employer[531].

Shortage and surplus occupations

When it comes to employee-profiles and skills needs, the steel industry faces the same challenges that other industrial sectors face – a mismatch between workforce demand and supply. Although the available data on occupations is not explicitly related to steelmaking, the analysis of the VET system highlights several profiles relevant to this sector. Table 25 provides an outlook of shortage and surplus occupations in the Spanish market.

Table 25 — Spain: Shortage and surplus occupations[532]

Shortage occupations	Surplus occupations
ICT specialist	Primary sector related occupations
Engineering and production related, high level, professionals	Plant and machine operators
Managerial related professionals	Building related occupations
Sales related professionals	Manufacturing related occupations
Shipping professionals	
Medical doctors and other health related professionals	

The list above is based on an assessment of the Spanish labour market and occupations with a significant mismatch are presented without any specific ranking. For the purpose of this study, only the occupational profiles relevant to the steel sector are considered. Three

[530] *Ibid.*
[531] *Ibid.*
[532] *Ibid.*

key occupational groups facing shortage were identified by Cedefop[533] as likely to require the definition of training strategies and VET policies in Spain (both at company and government level).

a) **ICT specialists**: With increasing digitalisation and the advent of Industry 4.0, the increasing demand for ICT professionals will be felt in the manufacturing and the steel sector. According to the most recent assessment, the total current number of ICT-related universities and VET students is around 70,000, which is insufficient to cover the demand. For ICT specialists, companies (including steel-related ones) require employees who possess the relevant technical skills and demonstrate initiative taking and teamwork competencies. These additional skill requirements make the search for appropriate professionals more difficult. Job vacancies for ICT specialists are among the most difficult to fill in Spain. In the near future (until 2020), the demand for programmers and developers (25,000-50,000 jobs), community managers/marketing ICT-based specialists (60,000-70,000 jobs), and specialists in digital visual design and creativity (15,000-45,000 jobs) is expected to be strong. This forecast is also confirmed through many interviews conducted in the most important steel companies, other industry stakeholders and VET providers.

AMETIC, the association who represents the digital technology industry in Spain, organises several programmes aimed at skilling and/or reskilling professionals. Among these is the "Profesionales TIC" programme, funded by PES and directed to unemployed persons, that is counted among Spanish best practices. AMETIC also organised in 2019, for the second year, the II Alliance Forum for the Development of Digital Talent in Spain, which took place on June 12 at the Caixa Forum in Madrid. After the success of the first edition, this event is considered a reference point for the Digital Talent Development and Competence ecosystem. More than 12,000 people have been trained since 2014 and over 60% of them were subsequently hired by enterprises. In the "PICE Joven eTIC" programme, youth between 16 and 30 years old are trained in ICT-related domains where enterprises face difficulties in filling vacancies. The pattern foresees that enterprises receive funding of EUR 1,500 per full-time young person hired for a minimum period of six months. Within the framework of the existing Spanish Tripartite Agreement on Continuous Training, AMETIC provides free courses to develop the ICT skills of employees in selected economic sectors.

b) **Engineering and production-related high-level professionals**: The demand for production and industry engineers in Spain is increasing (with most of the jobs offers – 71% - arising from manufacturing companies). The yearly supply of university graduates in the relevant industrial sector is around 13,000-14,000, with an additional 13,000 students enrolled in high level VET studies with manufacturing specialities. This supply still seems to be insufficient, since production engineers are among the job vacancies that are most difficult to fill.

Available data shows that more than 642,000 engineering professionals and support technicians are expected to be needed in Spain by 2025. The skills typically required are advanced ICT-related skills (see also the previous point), good planning and management skills, negotiation and communication skills. These additional "soft" skills requirements make the recruitment of appropriate professionals more difficult for enterprises and require training the people already hired (inside the company) or planning suitable vocational activities in traditional university courses or high-level VET studies.

In recent years, many activities along all the VET paths have been organised by schools (also primary schools sometimes), companies, universities and engineering associations to increase the interest of students in engineering/technical studies. In Spain, it is important to remember that the Polytechnic Universities of Madrid and Valencia are collaborating with the Royal Engineering Academy to increase the interest of 10-12-year-olds in technical and

[533] Cedefop, "Spain: Mismatch priority occupations", Skills Panorama, 2016, See: https://skillspanorama.cedefop.europa.eu/en/analytical_highlights/spain-mismatch-priority-occupations, Last visited on 05.06.2019

engineering studies. Moreover, the University of Valencia, Zaragoza, Oviedo and Rovira i Virgili have organised the "Girls' Day" to attract more female students to science and engineering studies. This is an important step, as the proportion of female engineering student is still very low (around 30%).

Since 2012 in the Spanish VET context, a new type of VET is provided called "Dual Vocational Training", (Royal Decree 1529/2012 of 8th November and the Order ESS/2518/2013 of 26th December). This "Dual Vocational Training", intended to complement the existing supply of VET studies, has still not fully been adopted in several manufacturing specialities such as Mechanical Manufacturing, Electricity and Electronics, and Installation and Maintenance Services. Some regional governments are also particularly active both in increasing the number and in strengthening the preparation of VET technicians in manufacturing-related specialities.

This innovative approach, conceptualised by the Basque Government, which passed the Basque Law for Vocational Training in December 2015, is to be considered as a best practice. This law intends to adapt in a more effective way the training supply to the current skills needs of regional companies, particularly manufacturing ones, and coordinate these measures with the main criteria established by existing national legislation. The Law aims at the full development of dual-training models, but also to increase participation of enterprises in designing the content of training (a task appreciated by the steel industry stakeholders that were interviewed) and also the internationalisation of curricula by improving collaboration with other EU training centres and the development of language skills within the curriculum vitae.

c) **Management professionals**. According to available data, managers and directors are among the occupations anticipated to have a strong employment increase, i.e. more than 700,000 jobs are expected to be created by 2025. Existing supply of university graduates is around 46,000 per year whereas the existing number of VET students in management-related specialities is around 97,000.

In Spain, a quantitatively significant part of the managerial skills supply comes from business schools (mainly private), often specialised in MBA postgraduate studies. Current supply is not sufficient to meet current demand. According to recent reports, managerial positions are among the most difficult job vacancies to fill. Managerial skills typically required by enterprises frequently include leadership, communication, planning and negotiation abilities, good knowledge of a foreign language, but in recent years also the use of ICT tools, as well as extensive work experience. According to the findings of the interviews that have been carried out, the transfer of knowledge is also an important skill for the managerial profile in the steel industry. This is due to the heavy restructuring measures carried out during the crisis. For managerial profiles it is difficult to attend continuous training activities, so post-graduate training is particularly welcomed, usually in business-oriented areas such as Finance, Sales, HR, Quality, Project management, etc. The Spanish Tripartite Foundation for Training finances training activities for Spanish managers in different domains. With regards to the steel industry, managers need to understand the changes this sector has been through and be able to face the challenges that the globalisation of the market has brought.

In order to fill the skills gaps mentioned above, several measures have already been taken by stakeholders in the Spanish education and training system. These involve both a skills anticipation scheme as well as strategies to up/reskill the current workforce. Various measures related to the implementation of VET policies have already been implemented to improve employability, especially of young and long-term unemployed people by increasing their skills and qualifications.

Skills anticipation strategy

Skills anticipation[534] strategy in Spain is designed to achieve a better match between the skills held by workers and those requested by the market. It needs, above all, tangible stakeholders and social partners involvement, both in the public and private creation of policies. In this sense, Spain has a long tradition of social dialogue around VET. As mentioned also in the ArcelorMittal Sustainability Report, the key to success is to maintain continuous dialogue to create a collaborative working environment based on mutual trust, understanding and respect. In the same vein, ArcelorMittal evidences the value of working closely with trade unions, and, in the Spanish experience, of reaching global agreements covering 94% of the company's workforce in 2018. In Spain, the skills anticipation strategy has been reformed recently, following the introduction of Law 30/2015 to improve the relatively poor labour market outcomes arising from the VET framework. The law regulates VET systems in relation to both employed and unemployed people. The aim is to coordinate and optimise all the activities in the VET field for a common view at regional and national level. The role of stakeholders such as employer associations and trade unions is to identify current and future training needs.

At national level, the coordination framework of skills anticipation activities is handled by the Ministry of Employment and Social Security (MITRAMISS) and the Ministry of Education, Culture and Sport. MITRAMISS is responsible for the PES, the Observatory of Occupations, and the State Foundation for Training and Employment. The Ministry of Education, Culture and Sports, on the other hand, is responsible for the Observatory of Professions and the National Qualifications Institute. Through PES, the State Foundation for Training and Employment, and through INCUAL, the two above mentioned Ministries have to coordinate their activities and methodologies to design and implement an effective skills anticipation strategy. One additional element in this strategy is a effective evaluation of training activities, to select the most innovative VET system[535].

At the regional level, the focus is on local demand. The responsibility in matching supply and demand in training needs is up to the regional governments. Social dialogue takes place between workers and employers through Sectoral Joint Committees, which are responsible for assessing the skills content of qualifications and the adequacy of training provision in relation to businesses' needs. Reforms in skills anticipation activities are still being developed, but further changes are expected, particularly with respect to the role of regional authorities in anticipating skills.

The budgetary cuts experienced by labour market policymaking at the beginning of the economic crisis are likely to have hindered skills anticipation activities. Furthermore, effectively disseminating information through career and vocational guidance channels and reaching target groups (e.g. small businesses and their employees; self-employed workers) continues to be a challenge.

Education and training

Social dialogue in Spain started again in 2018, after a period of recovery that followed a crisis characterised by austerity policies and unilateral policymaking. From the beginning of its term, the government expressed strong commitment to social dialogue, which was accompanied by moderate but reassuring growth in the country. As a result, tripartite negotiations and consultations were carried out on a number of issues. On other matters, trade unions and employers negotiated on a bipartite basis[536].

The dual system in VET is still generally considered the best way to promote an industry driven VET. Dual VET or dual learning, understood as alternating training periods in an

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[534] *Ibid.*
[535] Cedefop, Skills Panorama, "Skills anticipation in Spain", https://skillspanorama.cedefop.europa.eu/en/analytical_highlights/skills-anticipation-spain, Last visited on 03.06.2019
[536] See: https://www.eurofound.europa.eu/country/spain, Last visited on 14.06.2019

education institution and in the workplace, has been implemented, but with no significant impact on the system. In Spain, pilot experiences in some regions have given way to consolidated projects throughout the state, reaching a good number of apprentices (> 20,000), with 10,000 companies involved and around 900 dedicated education centres. These figures are positive but remain low in the general Spanish VET context, with barely 3% of students pursuing this type of vocational training. In the Spanish Steel Industry, the majority of stakeholders and companies are interested in improving dual learning schemes in this specific sector. To do this efficiently, better coordination between the VET system and academia is needed, to design specific training paths for imparting competencies and soft skills quickly usable in the workplace.

The Alliance for dual VET (Alianza para la FP Dual) is a state-supervised network of companies, centres and institutions, committed to developing dual VET in Spain. It is promoted by the Bertelsmann Foundation, the Princess of Girona Foundation, important business organisations like CEOE-CEPYME, the Spanish Confederation of Employers' Organisations and the Chamber of Commerce of Spain. The Alliance, launched in 2016, already has more than 650 members, many of which are companies. Its aim is to improve the legal framework of dual VET and increase the prestige of VET in general. The third Alliance forum for dual VET, held in October 2017, gathered prominent state representatives, regional administration agents and members of the alliance to review progress and discuss future challenges to make dual VET the most popular choice.

Also, it is foreseen that dual VET will increase its role in the general framework of the Spanish VET system. In the steel industry, even though training needs in each company could be identified by HR, a better coordination with public institutions both at national and regional level is required to address these needs. Training activities are necessary for personnel at all qualification levels to give the steel sector a decisive boost toward innovation, an aspect generally missing in the country, especially in the last decade. Industry 4.0 and digitalisation could be the fields in which the Spanish VET system and the dual VET in particular can gather momentum in a decisive way. November 2018 marked the sixth anniversary since dual VET system was first introduced in Spain. It was then further developed through 'training and apprenticeship contracts' established by law (Royal Decree 1529/2012).

In 2017, with the Resolution of 7 June 2017 of the Directorate General of Employment, the second Collective Agreement of the industry, technology and services of the metal sector was registered and published. In Art. 41. "Object and purpose", it is established that:

"The signatory organisations of the present Agreement consider the development and updating of the professional capacities of the workers and entrepreneurs of the Metal Sector as a priority and essential, in order to contribute to the determination of the specific qualifications and professional competences of the Sector, as a basis for the identification of the training, orientation and professional insertion most appropriate to the needs, individual and collective, of workers and companies, as well as on safety and health at work".

It seems that this collective agreement could also be an effective legislative instrument to encourage more updated vocational training paths to align the Spanish steel industry with new skills needs in this sector.

The case of ArcelorMittal

In its Sustainability Report, ArcelorMittal - the main steel producer in Spain - provides an overview of the challenges that the steel industry will face in the following years. The need for developing and retaining skills in engineering and science to maintain the company at the "forefront of innovation and performance" emerges very clearly from this report. Among other areas, ArcelorMittal defines as crucial those relating to lifecycle analysis, robotics, data analysis, nanotechnologies, circular economics and 3D metallurgy. The skills required for an increasingly digitalised industry need to be coupled with the ability to adapt to change, exploit new technology, and thrive in a complex workplace.

Rather than upskilling or reskilling the current workforce, ArcelorMittal highlights the importance of recruiting people with new profiles to face challenges linked to the technological evolution of the industry. "Digital leaders" are sought who can "identify digital opportunities for value creation and differentiation, drive the development of new capabilities and make full use of digital capacity"[537].

The image of the steel sector

According to data from the Unión de Empresas Siderúrgicas (Spanish Steelmaking Companies Union - UNESID), 70% of the steelmaking workers in plants are process operators, 15% are engineers, and 15% are external support. The turnover of the sector is below 3%. Age distribution peaks are in the ranges 32-37 and 55-60 and over (soon-to-be retiring) [538].

Interviews with Spanish industry stakeholders and education providers reveal that the image of the steel sector in Spain, as in many countries in Europe, is not very appealing. The industry is associated with pollution, harsh working conditions, dangerous and unhealthy work environment, as well as low salaries. Furthermore, the crisis has brought a sensible decrease in the workforce volume, the salaries and in work stabilisation[539].

The environmental impact of the steel industry especially in the northern regions of the country has been important in the past and also impacts public health. At present, the situation has improved a lot, but it is important to raise awareness about all the measures taken by steel companies to improve the sustainability of the sector. Overall, working conditions and professional competences employed in this industrial sector (e.g. ICT competences, production processes, process optimisation, Big Data analytics) have also been upgraded.

[537] Interview notes - Industry Stakeholders, Senior representative at ArcelorMittal Spain
[538] UNESID, Platea, Comité Técnico de Recursos Humanos, "Jornada : Soluciones del acero a los retos de la sociedad", See: https://aceroplatea.es/docs/documento207.pdf, Last visited on 14.06.2019
[539] Syndex, 2018, op. cit.

7.4. Industry 4.0

The advent of Industry 4.0 is one of the four major steps in the evolution of manufacturing that shaped modern societies since the end of the 18th century. While the introduction of coal-powered steel engines marked the first fundamental shift in the optimisation of industrial processes, bringing about substantial increases in productivity as well as the first interactions between workers and machine tools, the birth of modern steelmaking did not occur until the 19th century. Following the 2nd Industrial Revolution, which was marked by the invention of the production area, the improvement of transportation technologies and the electrification of industrial processes, the production of cheap steel was achieved for the first time through the Bessmer process and the introduction open heart furnace. One century later, the advent of automation led to the 3rd Industrial Revolution: computer technology led to a progressive automation of manufacturing, reducing manual work and further increasing the industrial output. This revolution was also marked by the introduction of Six Sigma and Lean Management, which influenced the development of work in assembly lines and factories by focusing on optimisation and the removal of production inefficiencies. "Another important influence is computer-integrated manufacturing (CIM) which is the integration of computers into the planning and production processes with the objective to control the entire production process"[540].

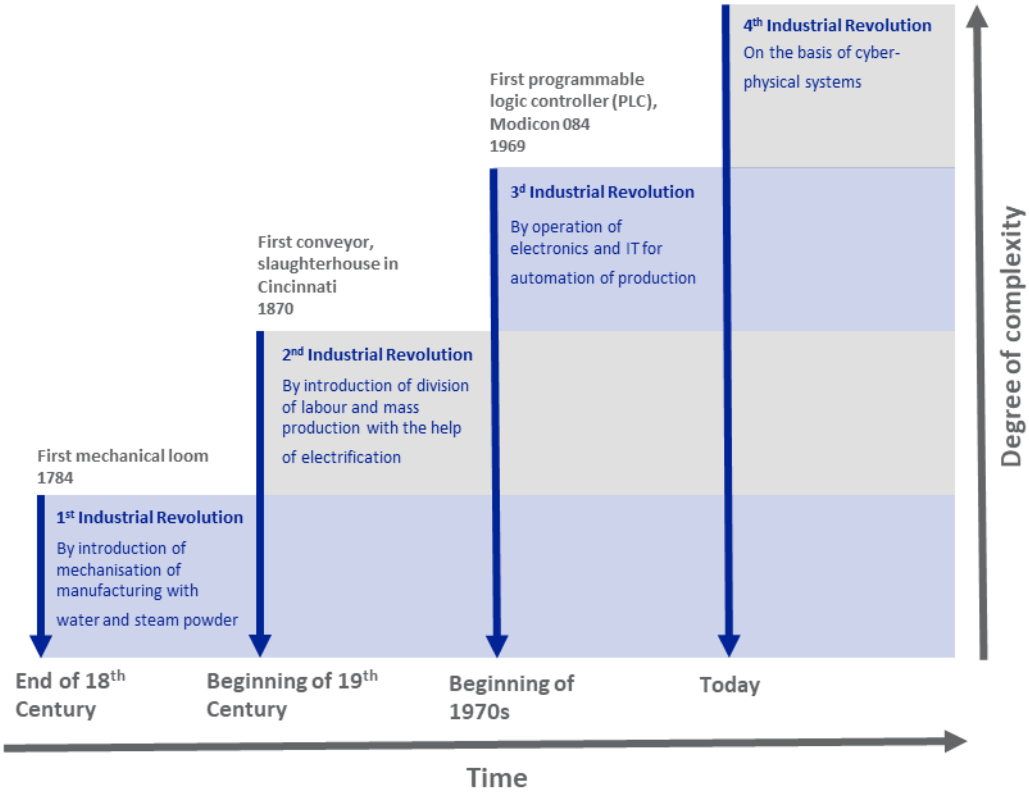

Figure 18 — The four Industrial Revolutions[541]

Industry 4.0 is characterised by the integration of a multitude of breakthrough innovations in process automation, which are linked to the advances in ICT and the increasing operationalisation of the IoT. Concrete examples linked to steelmaking include, among others, Cyber Physical Systems (CPS), Big Data analytics and Decentralised Control Systems. The table below provides a breakdown of the main subcategories linked to key Industry 4.0 concepts.

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[540] Gehrke, L. et al., *A Discussion of Qualifications and Skills in the Factory of the Future: A German and American Perspective*, 2015, p. 6
[541] Ibid., p. 5

Table 26 — Subcategories linked to Industry 4.0 concepts[542]

Category	Subcategory
Cloud Computing	-
IoT	• IOPeople • IOEverything • IOData • System of Systems (SoS) • Web-Based Organisation
Embedded Systems	• Cyber-Physical(production) System CPPS • Wireless Sensing (Nodes/Network) • RFID • Smart Sensing and Actuators
Smart Factory	• Ecosystem of Smart Factories
Inter Connection	• Networking • Interoperability • Vertical Integration of Production Systems • Horizontal Integration of Partners in Value Chain (Via Value Creation Networks) • Simultaneous Planning of Products and Production Processors • Cross-Functional Activities
Servitisation	• Product Service Eco Systems
Virtual and Augmented Reality	-
Value Chain	• Added Value • Supply Chain Flexibility and Visibility • SCM and Logistics
Mass Customisation	• Individualisation • Personal/Product Experience • Production • Product
Digitalisation	• Digitalisation of Physical Processes • Virtualization Virtual Assistance • Digital Transformation • End-End Digital Integration • Simulation and Virtualization
Adaptability	• Adaptive Manufacturing
Agent Theory	• Multi-Agent Systems
Intelligent and Autonomous	• Intelligent and Autonomous Shop-Floor/ Processes • Tailored Products • Connected/Smart Products and Machines • Self-Organised
Decentralisation and Distributed	• Decentralised decisions Decision Support Systems (DSS) • Networked and Distributed Data Diffusion
Data Analysis	• Big Data • Information Provision • Information Transparency • Real Time Data • Promptly Analysing Data System • Open Data
Security	• Safety • Privacy • Knowledge Protection

[542] Santos, C., Mehrsai, A., Barros, A. C., Araújo, M., Ares, E., "Towards Industry 4.0: an overview of European strategic roadmaps", paper prepared for the Manufacturing Engineering Society International Conference 2017, MESIC 2017, 28-30 June 2017, Vigo (Pontevedra), Spain

Category	Subcategory
3D Printing	-
Collaboration	• Collaboration Network • Co-Innovation • Human Machine System • Communication and Collaboration • Synchronous Operations • Information Sharing
Miscellaneous	• Standards • Physical Assistance • Production Time Improvement • Resilience • Scalability • Complex Event Processing (CEP) Complexity Management • Systemization of Knowledge • Modularization • Gamification • MechaTRONICS • Adaptronics • Multidisplinary • Holonic Manufacturing • Resource Pooling • Condition Based Monitoring • Synchronous Operations • Information Sharing

7.5. Abbreviations and bibliography

7.5.1. Abbreviations and acronyms

AI – Artificial Intelligence

ANOVA – Analysis of variance

ASME – American Society of Mechanical Engineering

BAT – Best Available Techniques

BOF – Basic Oxygen Furnace

BSPS – British Steel Pension Scheme

CASR – Centre for Advanced Steels Research

CBC – Choice-Based Conjoint

CCS – Carbon Capture and Storage

CCU – Carbon Capture and Usage

CDA - Carbon Direct Avoidance

CKU – Centre of Continuing Education

CIM – Computer-integrated manufacturing

CPS – Cyber Physical Systems

EAF – Electric Arc Furnaces

EBITDA – Earnings Before Interest, Taxes, Depreciation and Amortisation

ECSC – European Coal and Steel Community

EDLESI – Equality and Diversity Learning in the European Steel Industry

EEC – European Economic Community

EIB – European Investment Bank

ERDF – European Regional Development Fund

ESCO – European Skills, Competences, Qualifications and Occupations

ESF – European Social Fund

ESSA – European Steel Skills Agenda and Strategy

ESTEP – European Steel Technology Platform

ESIF – European Structural and Investment Fund

ETS – Emissions Trading Scheme

EU – European Union

FNBE – Finnish National Board of Education

HE – Higher Education

HR – Human Resources

I2M – Integrated Intelligent Manufacturing

ICT – Information and Communication Technologies

IoT – Internet of Things

LTIFR – Lost Time Injury Frequency Rate

MCF – Missing Chapter Foundation

MOOCs – Massive Open Online Courses

NFN – National Foresight Network

NSIC – New Steel Industry Challenges

OECD – Organisation for Economic Co-operation and Development

OSH – Occupational Safety and Health

OOM – Opleidings- en Ontwikkelingsfonds voor de Metaalbewerking

R&D – Research & Development

R&D&I – Research & Development & innovation

RFCS - Research Fund for Coal and Steel

ROA – Researchcentrum voor onderwijs en arbeidsmarkt

SCU – Smart Carbon Usage

SDGs – Sustainable Development Goals

STEM – Science, Technology, Engineering and Mathematics

TRL – Technical Readiness Levels

US – United States

VDI – Verein Deutscher Ingenieure

VET – Vocational Education and Training

WBL – Work-based learning

WEF – World Economic Forum

WG – Working Group

WTO – World Trade Organization

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