Blueprint "New Skills Agenda Steel": Industry-driven sustainable European Steel Skills Agenda and Strategy (ESSA)

Company Skills Requirements and Foresight

Deliverable D3.2

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Content

1. Introduction

In 1951 the European Coal and Steel Community (ECSC), which is considered as the forerunner of the European Union (EU), was established to unite European countries economically and politically in order to secure lasting peace. [1] Therefore, steel, along with coal, were the two main strategic industries in which a common European project was first launched, even before establishing the European Economic Community. Even today, with some 500 active production centers in 24 Member States, the steel industry represents an important asset for the European economy. With an annual production of about 160 million tons of crude steel and an annual turnover of 170 billion euros, Europe is currently the largest importer of steel and the second largest producer of steel in the world after China. [2] European steel contributes to a number of transforming industries, in particular the automotive, construction and infrastructure, robotics, advanced machinery and tools and household appliances. It provides more than 320,000 direct jobs and 1.5 million indirect jobs. [2]

Recently, the steel industry has been facing rapid and constant changes due the next industrial revolution: Industry 4.0. Rapidly growing digitalization has been profoundly transforming the dynamics of most industries, including the steel industry and impacting the entire operating ways of organizations. The manufacturing models are changing through the use of smart technologies such as robotics, artificial intelligence (AI), internet of things (IoT) and machine learning etc. The development of these technologies enable a new phase of automation that results in innovative and more efficient processes, products and services. [3,4]

Technological developments urging with digitalization will prompt a larger shift in demand for workforce skills as it transform occupations and is likely to accelerate skill shifts compared with the historical trend. Therefore, Industry 4.0 and sustainability appear to be the main drivers leading the evolution of skills needed in the European steel industry. [5]

A competent, multi-skilled workforce that can handle the adoption of advanced technologies is a major key condition to overcome the Industry 4.0 challenge. It can only be achieved through addressing and foreseeing the future skills requirements of the sector and updating the qualifications, knowledge and skills of its workforce.

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. [5] There will be high demand for workers with finely tuned technological, social and emotional skills—skills that in cases, machines are a long way from mastering. [6] The mix of physical and manual skills required in occupations will change depending on the extent to which work activities can be automated. General equipment operation (skills used by manufacturing workers), inspecting and monitoring skills will decline faster than other physical and manual skills. [6] All of these skills shifts and changes will be investigated in detail in this work.

In accordance with the technological and economic developments, ESSA WP3 (Industrial Requirements & foresights) focuses mainly on the function of jobs within the steel industry whereas WP4 (VET System Requirements) emphasizes occupational profiles in general. Our work is aimed be a sectorial and academic guideline for WP4 to identify the skill gaps of the current VET training programs and possible strategies to overcome them. Thus, in the long term, it roots for the development of the convenient, and well-prepared VET training programs to deliver the needed skills.

Thus, in this Deliverable, WP3 addresses the near future changes in the professional skills requirements of the steel industry facing Industry 4.0 and provides insights and hints from

varied perspectives to deal with the current skills requirements and as well as the future skills requirements urging with digitalization. It offers concrete examples to demonstrate how the steel company departments (particularly Human Resources (HR) Department), curricula developers, qualification providers and other stakeholders can use the generated profiles for job profile definitions during the assessment, career development and curriculum design, in order to support an organisational change process including digital transformation.

Additionally, this work package offers a brief guidance on how to connect the profiles to other frameworks, e.g. ESCO the European Classification of skills, competences and occupations. Finally WP3 will establish conclusions for their integration into the European Blueprint through analyzing the overall results and assessing their impact in the steel companies' organization and their staff.

Therefore, In the second section of the deliverable, initially, a detailed desktop research was carried our to determine the latest skills trends affecting the steel sector considering the future technological and economic developments summarized in WP2 (see deliverable D2.1 'Technological-and-Economic-Development-in-the-Steel-Industry-ESSA-D6.1.pdf') and skills development concepts stated in other recent sources (reports like Steel Sector Careers [5] and McKinsey [6], several book chapters and scientific articles). After, "ESSA skills Assessment and Foresight Questionnaire", a survey designed to identify the (1) current and future skills needs and (2) skills gaps as well as (3) the most relevant technological developments for the steel job profiles and define their importance for the European steel sector was introduced. The results of the survey was analysed and discussed. In the third section, 'family tree' concept was introduced as an efficient methodology during the development of the job profiles in an organizational structure. In addition, an European Steel Family Tree for the production and maintenance functions in steel companies was generated to be used as reference for the whole steel sector. This chapter also revealed the connection between the steel sector job profiles presented by ESSA project and occupational profiles of ESCO (the European Classification of skills, competences and occupations) database. The forth section offers the European Steel Sector Professional Role Profiles description concept as a standard template for the European steel sector and demonstrates how to use it, and how to integrate it into steel Hub training offer exchange platform in the ESSA Online Training Eco-system (OTS). Additionally its potential use in talent management and recruitment was presented. The skill categories and skill proficiency levels developed by the ESSA WP3 team are also introduced here. Moreover, the section demonstrates how to use learning outcome approach as a bridge to connect the world of employment (industry) and of education and training. Since the training offers come with their learning outcome, this concept connects the training programmes with the industry skill needs which were presented by the Skills Assessment and Foresight Questionnaire in section 2.

2. Industry Skills Requirements

2.1 Identification of the skill needs of the European steel sector workforce

The steel industry has currently undergone rapid and constant changes due to the increasing digitalization, coming with new challenges. The application of new technologies in this sector already supports and can further sustain the optimization of the entire production chain, whereas the steel production is already automated to a certain extent and often the systems work in an isolated way. Despite the fact that steel sector has always been considered a mature sector with a low level of technological development, and most of workers (although experienced in industrial and metallurgical issues) lack of the recent technological skills, the steel industry is in the process of becoming smart and more agile evolving towards industry 4.0 and most of steel companies are digitizing their processes, incorporating ICT and Industry 4.0 technologies to melting, casting, rolling and finishing sub-processes. [5]

Therefore, in general, the international response to Covid-19 has been to accelerate industrial digitalization across the entire manufacturing sector through existing or new measures related to Industry 4.0 technologies. [7] The adoption of smart technologies that increase agility and flexibility in operations has become a top strategic priority [8], therefore making the upskilling and reskilling of the workforce more indispensable and a higher priority than ever.

Simultaneously to the digitalization process, the industry is seeking solutions for an efficient use of resources and the reduction of CO2 emission levels while maintaining its competitiveness and economic development. Thus, sustainability concerns are gradually being incorporated both into the agendas of policymakers and the strategies of companies. These strategies are mainly focused on improving the energy efficiency, sustainability and optimal use of resources as well as safety and employee well-being. [9,10]

Industry 4.0 and sustainability appear to be the main drivers leading the evolution of skills needed in the steel sector. [5,6] This results in a demand of new skills for the steel workforce and an acceleration of skill shifting compared to the historical trend.

The steel industry expectations from digitalization include, first of all, the optimization and the interactions of the individual production units, within the entire production chain (and beyond), leading to reach the highest quality, flexibility, and productivity. Adaptive online control, through-process optimization, through-process synchronization of data, zero-defect manufacturing, traceability, intelligent and integrated manufacturing will be the most important digitalization trends in the future. Digitalization offers a range of opportunities to increase quality of finished products, reduce lead time and increase productivity by improving the overall production efficiency of a plant. [5] Digital technologies, through the continuous adjustment and the optimization of the processes online, aim to improve the flexibility and the reliability of processes, to maximize the yield, to improve the product quality and the maintenance practices. Such technologies further contribute to increase the energy efficiency and to monitor and control the environmental performance of processes in an integrated way. Real-time decision making in steel production chain considering technological, economic and environmental aspects at the same time is only possible through the integration of new IT, automation and optimization technologies. Additionally, Predictive Maintenance techniques can be implemented by equipment monitoring combined with intelligent decision methods. Machine Learning and Data Mining techniques can be used to anticipate maintenance work before something goes wrong. Moreover, the maintenance can be scheduled, and many checks can be made remotely, resulting in significant improvements in the equipment maintenance. Furthermore, Knowledge Management represents a key factor for the improvements to be achieved in the digitalization process. In order to overcome the

barriers due to heterogeneous distribution over the individual staff members, human obliviousness, and knowledge erosion by leaving staff members, new approaches based, for instance, on the methodology knowledge-based decision support system (decision-making based on relevant knowledge, which is based on artificial intelligence, and on the application of information and communication technologies) is in development.

Due to the introduction of the mentioned technologies and systems, the skills and skill levels needed for the job profiles related to the steel sector are changing continuously. These technological developments will transform the steel industry occupations and force the sector to improve quality and relevance of skills to meet the industry needs. [5,6,11] Therefore, there is an urgent demand for addressing and updating the required qualifications, skills and knowledge of its workforce in order to build the highly qualified, multi skilled workforce that can handle the new technology introduced by Industry 4.0. Building such competent personnel requires two types of changes across the workforce: upskilling, in which staff gain new skills to help in their current roles, and reskilling, in which staff need the capabilities to take on different or entirely new roles. [11] The first condition for the reskilling and upskilling of the workforce is to identify its skill needs.

The first objective of this WP3 is to identify and specify these skills and training needs within the steel sector, considering a framework of growing digitalization, to be incorporated into VET and tertiary education training curricula, making '<u>definition of recent and future skill needs and redefinition of professional profiles</u>' the first WP3 task.

An important conclusion from the final report of Steel Sector Careers[1], is the concept of key exogenous factors that are expected to change in a steel company. [5] These factors will substantially affect the tasks that steel professionals will be required to perform, which in turn will influence the skills required to perform these tasks. They can be described as follows:

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. The advances in robotics will allow collaborative robots to become more and more autonomous and relieve workers from simple and repetitive tasks. At the same time, human intervention will become more important in the maintenance and supervision of machines. [5]

Organisation & Structure - 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 [12]. Decisions will rest with small and agile teams of operators led by high-skilled engineers.

Working Environment – With an already high degree of automation, many steel plants are state-of-the-art facilities, with little human intervention and human resources is concentrated mainly in the control rooms, where operators can coordinate the various operations of the plant. 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.

According to these factors, 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.

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. Workers will 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. [5]

As pointed out by McKinsey's research (addressing the industry in general) and Steel Sector Careers report (focusing only on the steel industry), the main observed consequence of the mentioned technological changes is that the demand for technological skills will grow rapidly as companies deploy automation, robotics, AI, advanced analytics, and other new technologies. [5, 6,13] This surge will affect demand for basic digital skills as well as advanced technological skills such as programming. [6] Awareness of data security and protection will acquire importance as will trust in new technologies. [5] It is important to mention that McKinsey's research is not steel-sector focused but involves general manufacturing industry.

Accompanying the adoption of advanced technologies into the workplace there will be an increase in the need for workers with finely tuned social and emotional skills—skills that machines are a long way from mastering. [5,6] So, the demand for social and emotional skills will grow also rapidly.

As mentioned, while automation and digitalization of work processes increase, workers will be required to take charge of less automatable and more complex tasks, whose completion necessitates solid literacy, numeracy, problem-solving, and ICT skills together with soft (non -technical) skills of autonomy, coordination and collaboration. [4,14] 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. [5] Work activities that require only basic cognitive skills will particularly decline as automation advances. The decline will be more important, as machines increasingly take over straightforward data input tasks and cause a drop in the need for basic data processing. Demand for cognitive skills will generally shift from basic to higher ones. [6] As a result, higher cognitive skills such as creativity, critical thinking, teamwork, problem-solving, decision-making will increase in importance through 2030, together with an aptitude for continuous improvement and lifelong learning. [5,6]

There will be higher demand placed on all members of the workforce in terms of managing complexity, complex information processing and higher levels of abstraction for obtaining simplified representation of the bigger wholes. [4] 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. 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. [5] Moreover, there will be a need to coordinate between virtual and real machines as well as between manual and robotic systems, hence employees will be expected to act more on their own initiative, have excellent communication skills and be able to organize their own work. [4] The importance of managerial skills increases significantly on a five-year forecast. [5] Other types of higher cognitive skills—such as advanced literacy and writing (language proficiency), transversal (soft) skills and quantitative and statistical skills—will not see a similar increase in demand, the need for them could remain stable or even decline to 2030. [5,6]

The mix of physical and manual skills required in occupations will change depending on the extent to which work activities can be automated. General equipment operation (skills used by manufacturing workers) and inspecting and monitoring skills will decline faster than other physical and manual skills. So, the demand for physical and manual skills, which include general equipment operation, will also drop, but it seems that still will remain the largest category of workforce skills in 2030 in many places, accounting for an important percent of the total hours worked. [6]

As a consequence of the increased focus on energy efficiency, sustainable steelmaking and environmental awareness, green skills are projected to become highly important among European companies over the next five years.

Green skills are considered key to maintain the competitive edge of the European manufacturing industry including the steel sector. [5] This can be explained by the efforts that the industry is making to meet the EU's 2050 environmental targets. It appears to be more common for companies to expect shop floor workers to have competences in resource efficiency, material reutilisation and recycling.

Figure 1 shows the results of the survey carried out by the McKinsey Global Institute in order to contrast the importance of skills needed today with those required in the future. [6] The results are in consistence with the Steel Careers Report and other references: Overall, employers expect to need more of the social and emotional, higher cognitive, and technology skills in the future, and less of the basic cognitive and physical and manual skills. [6]

Companies will need to make significant organizational changes at the same time as addressing these skill shifts to stay competitive. The survey highlights a new emphasis on continuous learning for workers and a shift to more cross-functional and team-based work. [6] As tasks change, jobs will need to be redefined and companies will need to become more agile. There is also a concern that lacking the skills needed for automation adoption will hurt the future financial performance. [15]

Firms in the forefront of automation adoption expect to attract the talent they need, but slower adopters fear their options will be more limited. [16, 17]

On the other hand, firms should collaborate with educators to reshape school and college curricula. Industry associations can help build talent pipelines, while labor unions can help with cross-sector mobility. [18]

One of the main observed consequences is that workers have great difficulties to deal with the increasingly automated, robotized and digitized processes i.e. a more highly skilled workforce is required, and skill needs are emerging. This is not only an issue of the steel sector, but a general trend. Thus, the World Economic Forum has already predicted that "by 2020, more than a third of the desired core skill sets of most occupations will be comprised of skills that are not yet considered crucial to the job today." [19] Organizations face a difficult conundrum as culture, structure, and mindset form a self-reinforcing vicious circle: Changing mindsets requires a different structural and cultural context, and changing the context requires leaders with a different mindset, who feel comfortable in agile environments. It is important to understand that addressing mindset issues is both a people and organizational challenge. [20]

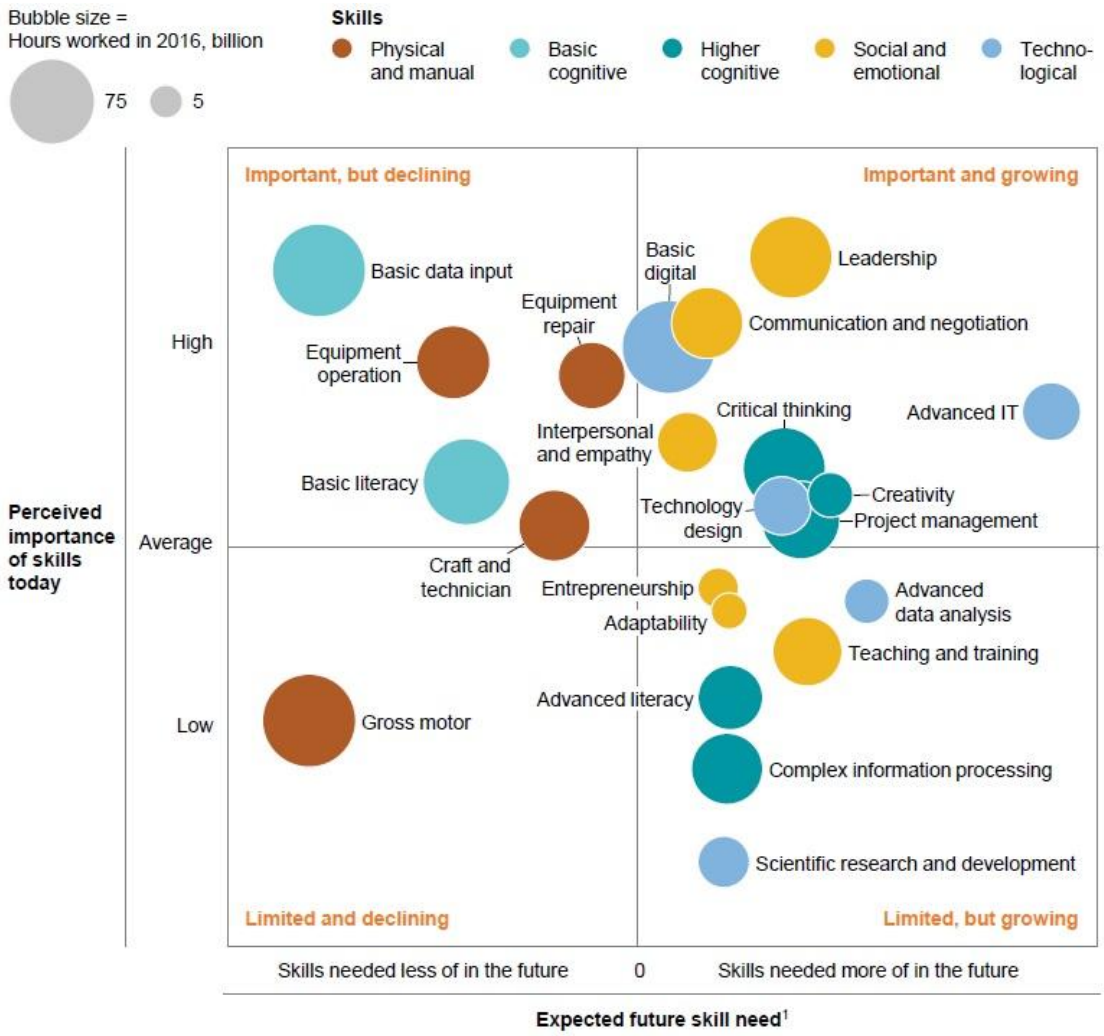


Figure 1: Skills of today vs skills of tomorrow. The results demonstrate that the technological, social and emotional skills will become even more important. [15]

In conclusion the general trend observed points to a greater need for technological knowledge and less administrative and technical knowledge, therefore the ESSA project will serve steel companies to specify and identify these skills and knowledge needs, adapting them to their future scenarios. By comparing existing and future skills demands and needs of the steel industry the main result of this WP will be obtained: an identification of workforce gaps that will be set as a basis for next tasks, particularly WP4.

2.2 ESSA Skills Assessment and Foresight Questionnaire

2.2.1 The Objective, Design and Key Facts

Complementary to the previous bibliographic study, a questionnaire has been carried out with the participation of steel companies in Europe to get an overview of skill needs in the European steel industry in the coming years. A multilingual survey is designed to identify the (1) current and future skills needs and (2) skills gaps as well as (3) the most relevant technological developments for the steel job profiles and define their importance for the European steel sector.

Table 1 shows the chosen job profiles for the survey with their ESCO codes and definitions.

Table 1: 9 steel sector job profiles selected for the questionnaire with their ESCO codes and descriptions

1321.1.1.7 Metallurgical managers coordinate and implement short and medium term metallurgical or steel-making production schedules, and coordinate the development, support and improvement of steel-making processes, and the reliability efforts of the maintenance and engineering departments. They also partner with ongoing remediation initiatives.
2141.9 Process engineers apply engineering concepts in order to improve all kinds of production and manufacturing processes in terms of efficiency and productivity. They evaluate the variables and constraints present in given processes and present engineering solutions to optimise them.
2141.7 Maintenance and repair engineers focus on the optimization of equipment, procedures, machineries and infrastructure. They ensure their maximum availability at minimum costs.
3119.13 Process engineering technicians/supervisors work closely with engineers to evaluate the existing processes and configure manufacturing systems to reduce cost, improve sustainability and develop best practices within the production process.
3122.4 Production supervisors coordinate, plan and direct manufacturing and production processes. They are responsible for reviewing production schedules or orders as well as dealing with staff in these production areas.
7411.1.1.2 Industrial electricians install and maintain electricity cables and other electrical infrastructure in large industrial and commercial buildings. They perform inspections and repair defective parts of electrical systems to ensure efficiency.
8121 Metal processing plant operators monitor, operate, adjust and maintain single-function process machinery and equipment to process and convert mineral ores and refine, harden, roll and extrude metals.
7223 Metal working machine tool setters and operators set and/or operate various machine tools, working to fine tolerances.
9329.1 Factory hands assist machine operators and product assemblers clean the machines and the working areas. Factory hands make sure supplies and materials are replenished.

An online survey was conducted between November 2020 and January 2021. In this survey, both the technical development and the current and future skill requirements in nine occupational profiles within these companies were determined. The profiles have been pre-selected and cover the broadest possible range of occupational profiles in the steel sector.

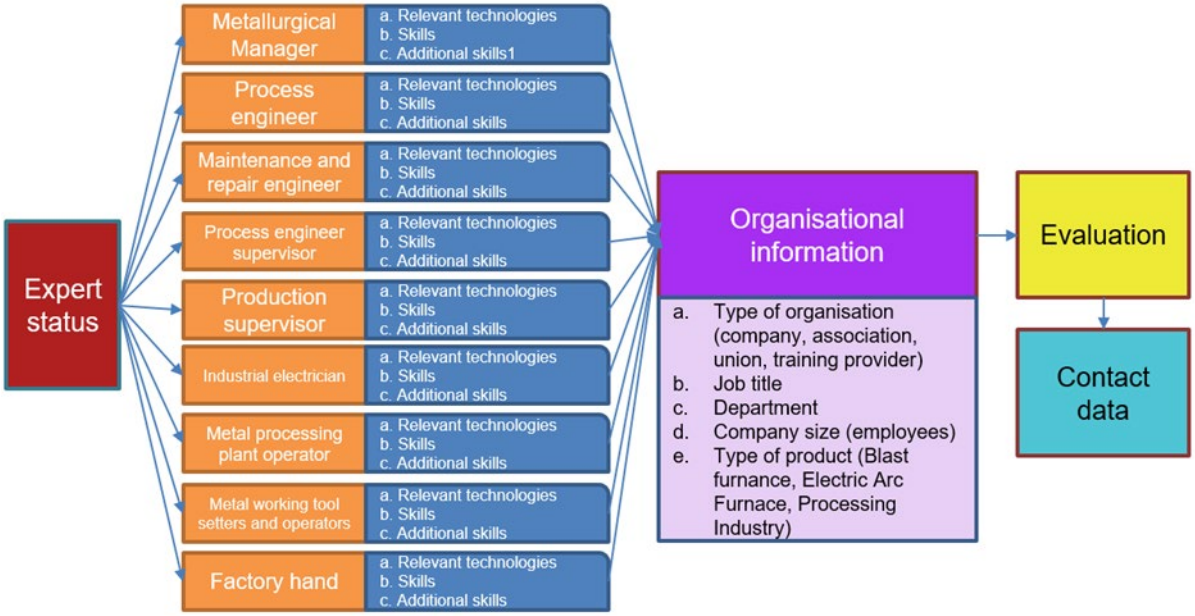


Figure 2: Structure of the survey

Participants were first asked for what occupational profiles they considered themselves as experts (see Figure 2). Subsequently, for each of the selected profiles, a specific question section related to technological and skill development followed. For this, a collection of relevant, emerging technologies identified by WP2 as well as the ESSA skill categorisation developed within WP3 were used. The detailed description of all the skills categories within ESSA skill categorization, and ESSA skill proficiency levels (Novice, Basic Actor, Practitioner, Expert, Master) were generated integrating relevant references and performing fruitful discussions among the subject matter experts of WP3, WP4 and WP5. This information was provided as a supportive material to make the survey more clear for the end-users. (see Annex II for the detailed description of the skill categories and skill proficiency levels). The participants were asked to define the needed current and future levels (0-4) of the selected skills, as well as to identify the relevance of the novel technologies (0-4) (Predictive Maintenance, New Generation of Sensors, Mechatronics and Advanced Robotics, Machine Learning, Big Data and Analytics, Cybersecurity, Internet-of-Services, Artificial Intelligence, Cloud Computing, Additive Manufacturing, Virtual, Augmented Reality, Internet of Things) for each occupation. Moreover, they had an optional question asking if they think any additional skills are needed for the chosen profile. As can be seen in Figure 2 which summarizes the structure of the survey, before the participant evaluated the questionnaire, some further characteristics of the respondent and the organisation (such as type of their organisation, their job title, department, company size, and type of product of their company) were enquired so that it later could be included in the ESSA Foresight Panel in a modified form. The participants were also asked to provide their contact data in order to get the survey results.The questionnaire was programmed using the survey software Limesurvey and placed online; the link to the survey was distributed through various channels, with a focus on project partners. The aim was not to provide a picture of the European steel sector as representative as possible, but to gain an initial insight into the views of people from the industry and to generate some assumptions, which should later on be validated within the project. Also the survey acted as a pilot test for the later development and conception of a more extensive ESSA foresight tool.

Survey results

The survey produced very detailed results for each job profile, technology type and skill category, as well as combinations of these elements, e.g. a specific type of skills within a specific job profile. In order to provide a clear, not overloaded overview, results for

combined job profiles and skill categories are presented below. First, however, a brief overview on the structure of the participants is given.

Participants

33 people participated, most of which used the Spanish questionnaire (12), the Polish questionnaire (9) and the English questionnaire (9)[1]. In average each of the participants assessed 3.4 job profiles, resulting in 113 job profile assessments (see Figure 2). The participants were predominantly employed by large companies with over 1,000 employees (27/33)[2] and mostly worked in the human resources / training department (19/33)[3]. This biased distribution can be attributed to the way of recruiting as well as the rather small number of participants.

2.2.2 Analysis and Results

2.2.2.1 Technologies

In terms of technologies, there were no major differences between the different occupational profiles. Therefore, we had a look at the overall results combining the different job profiles, so that we could determine the average impact of the different technologies on the job profiles, now and in the future (in 3 years).

The result show that it is believed that all of the technologies surveyed will become more important in the future (see *Figure 3*). Especially *Predictive Maintenance*, *New generation of sensors* as well as *Mechatronics and Advanced Robotics* are believed to play a major role in the future. It must be noted, however, that predictive maintenance, for example, already plays an important role today. This justifies the assumption that technological changes here might not be as extensive. The other way around Big Data and analytics could encounter a huge rise in relevance within the next three years.

[1] Further languages: German (4), Czech (1)

[2] 3 participants came from companies with 251 to 1,000 emloyees, one each from companies with 51 to 100 respectively 251 to 1,000 employees.

[3] Further departments: Management (4), Technical department (3), Machine operation, Logistics, Research & Development (1 each)

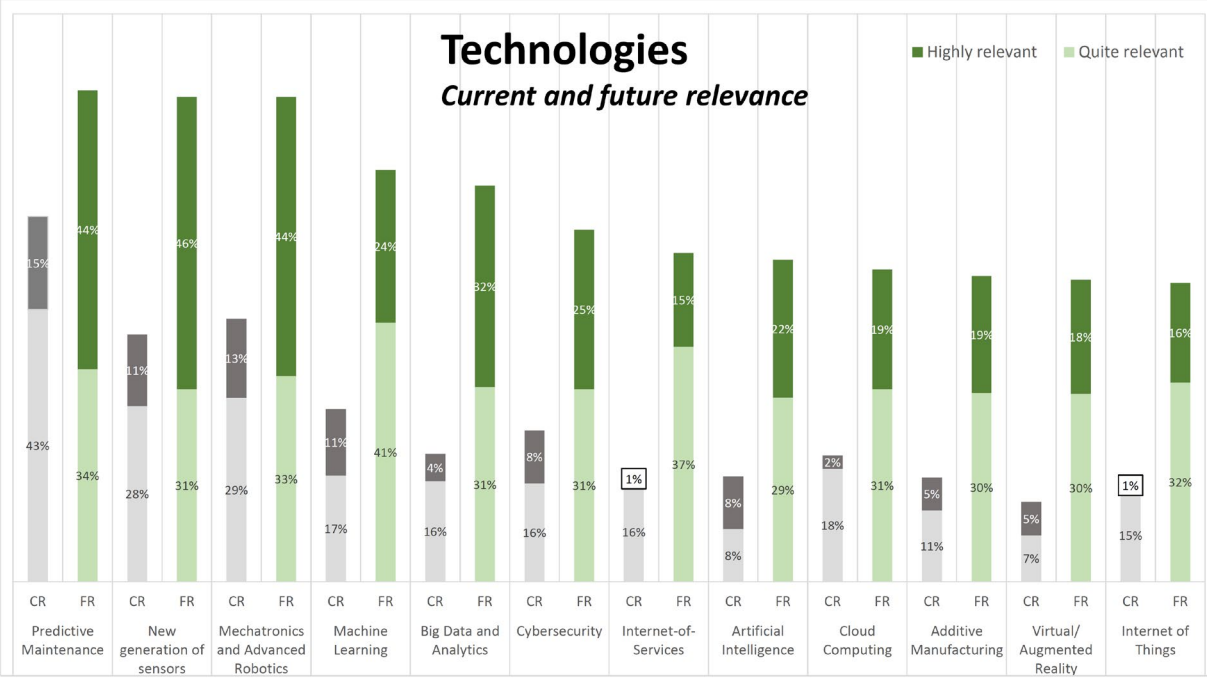


Figure 3: Current and future relevance of different technologies, proportion of job-profile-related assessments in which the technology was considered to be "highly" or "quite" relevant in the present and in the future (respectively).

This assumption is supported by *Figure 4*: In 22 percent of the job profile assessments the future relevance of the Big Data technology was assessed much higher as the current relevance, while it were only 5 percent for the predictive maintenance technology. The overall picture shows that technological developments in the steel industry will continue for the sector, even in the short term.

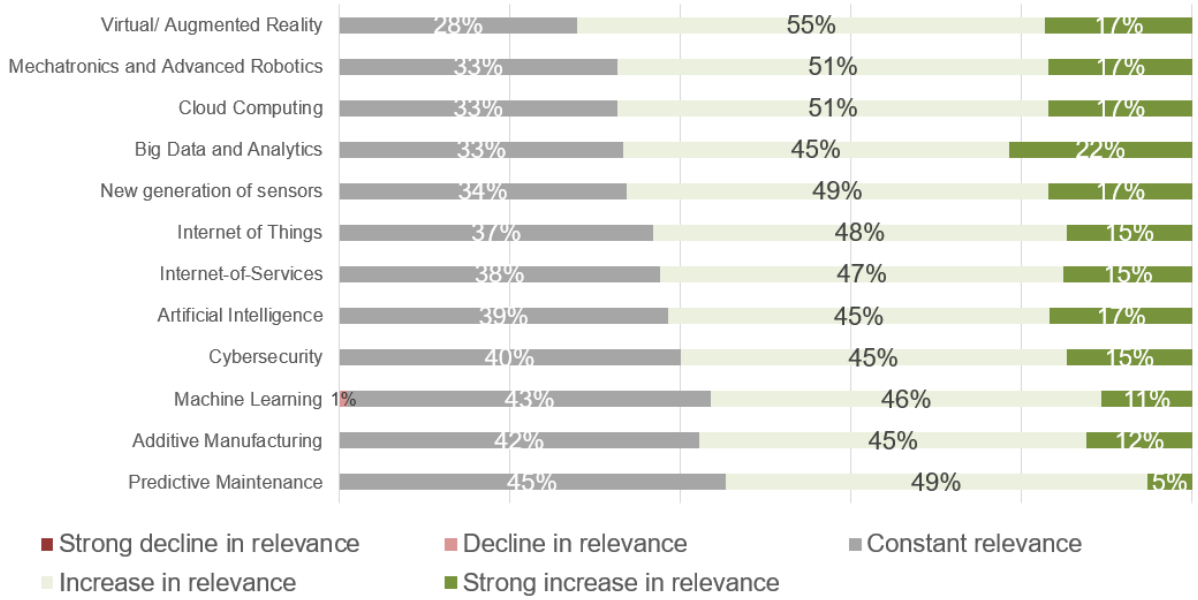


Figure 4: Development of relevance of different technologies from the present to a new future (3 years), proportion of job-profile-related assessments in which a (strong) decline, a (strong) increase as well as constant relevance was stated. "Strong" indicates a change of at least two levels on a five level scale.

2.2.2.2 Skills

Participants where then also asked to assess the currently required skill levels as well as the needed skill levels for the future (in 3 years) on a five level scale (*0: Novice, 1: Awareness / Basic Actor, 2: Practitioner, 3: Expert, 4: Master*).

Technical skills

Regarding technical skills it's interesting to note that *Gross motor skills and strength* will play a minor role across all job profiles, while also *Craft and technician skills* will more or less stay on the same level (see *Figure 5*). This could indicate that, due to technology, certain more manual activities could be automated. All other skill categories will rise more distinctly in relevance. If interpreted metrically[4], the absolute relevance of technical skills will rise by 0.5 points on the scale (from 2.0 to 2.5) on average.

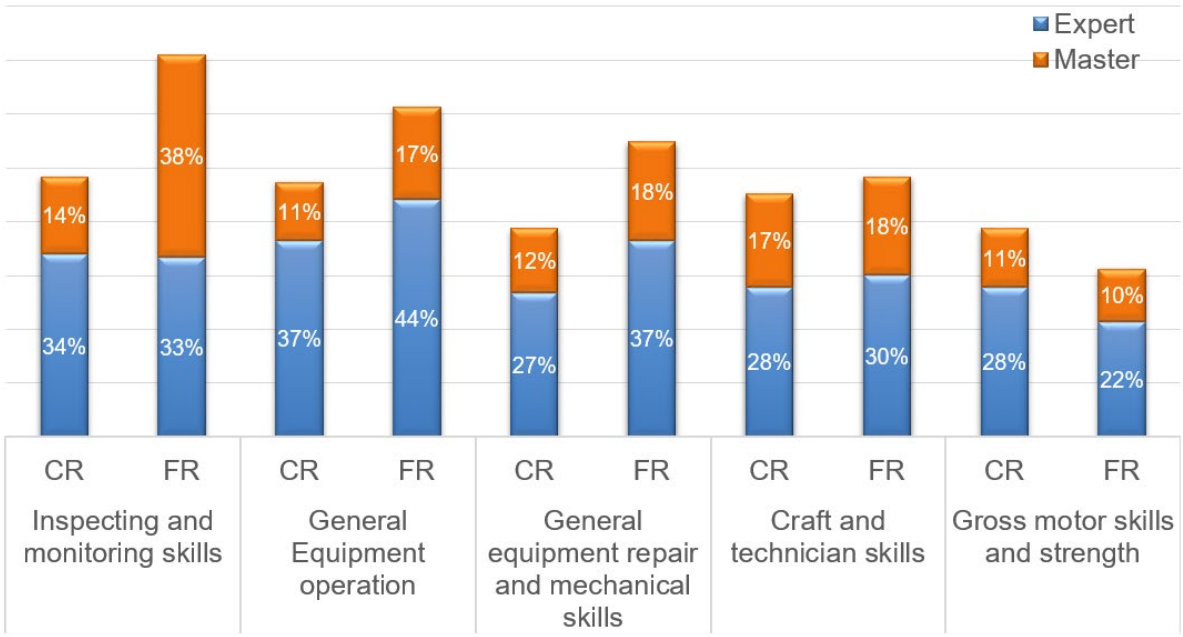


Figure 5: The need for different technical skills on Expert and Master Level now and in the near future (within 3 years) across all job profiles (combined frequencies).

Digital skills

Compared to technical skills, digital skills will experience a stronger increase in importance. *Figure 6* shows that all subcategories will require a much higher skill level in the future. However, there are also substantial differences between the subskills: Basic digital skills are transversal in a sense, as only in 1 percent of the assessments it was stated that there is no need for these basic digital skills in the future; whereas with regard to *Advanced IT skills and Programming* it were 17 percent of the assessments. Similarly, in 13 percent of the assessments it was assessed that not any *cybersecurity* skills will be needed in the future. Also it was rarer stated that a high level of skills is needed in these categories. Overall, the digital skills needs will rise from 1.5 to 2.2 points.

[4] For this statistic the used scale was transformed into numbers ranging from 0 (Novice) to 4 (Master).

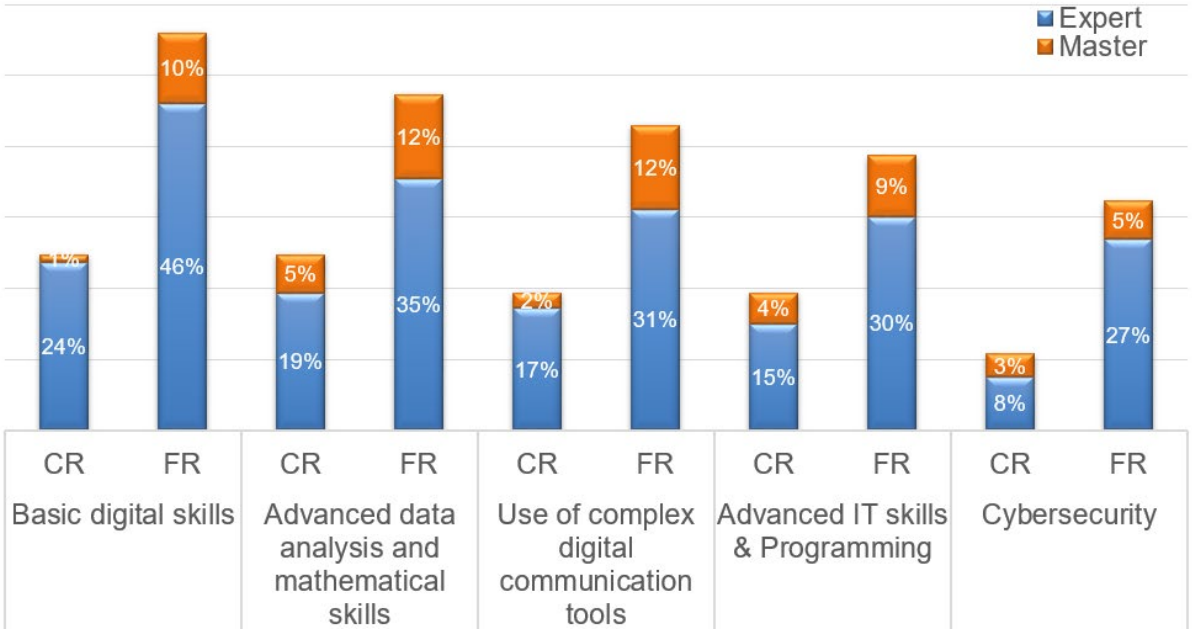


Figure 6: The need for different digital skills on Expert and Master Level now and in the near future (within 3 years) across all job profiles (combined frequencies).

Green skills

Similar to digital skills, it seems that green skills will also become increasingly important. As *Figure 7* shows this applies to all five green skills subcategories. The differences between the different categories are rather small. Within each sub-category, an increase in the required skill level by at least one level was noted in more than half of the cases. Overall, the needed skill level across all job profiles will rise from 1.9 to 2.6 points.

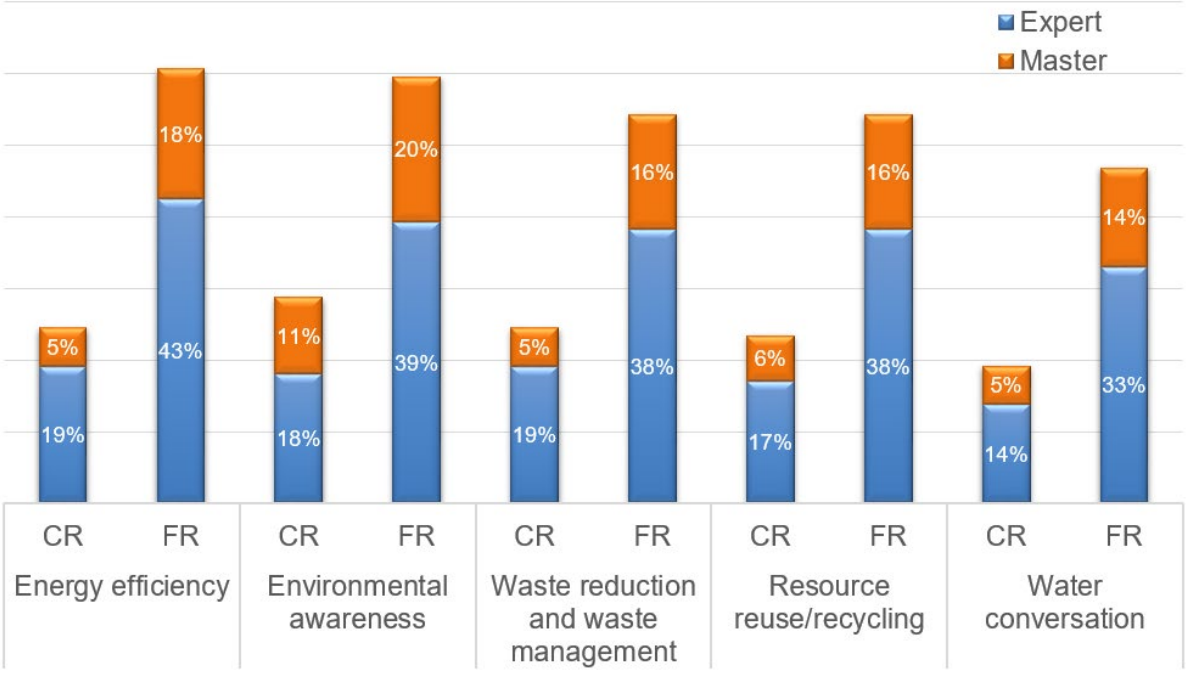


Figure 7: The need for different green skills on Expert and Master Level now and in the near future (within 3 years) across all job profiles (combined frequencies).

Social skills

Social skills are already very important in the present and will not strongly gain in importance (see *Figure 8*). The biggest changes are expected to occur with regard to learning related skills (*teaching & training others*, *adaptability and continuous learning*), where in over the half of the assessment an expected increase of needed skill levels was detected. This may refer to changing requirements and the need to adapt the workforce more continuously. Similar applies to *Entrepreneurship and initiative taking*, while consistency was diagnosed in more than half of the cases for the other two skill categories (*Leadership and managing others* & *Interpersonal skills and empathy)*. Overall, the needed level of social skills will grow from 2.0 to 2.5.

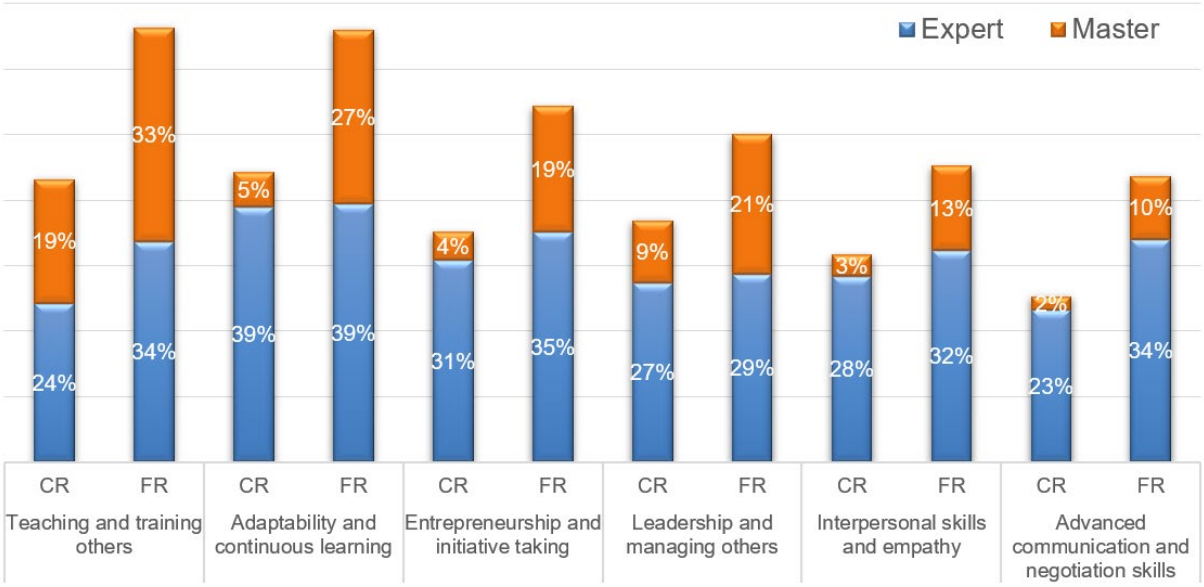


Figure 8: The need for different social skills on Expert and Master Level now and in the near future (within 3 years) across all job profiles (combined frequencies).

Personal skills

Like social, personal skills are partly already in place (see *Figure 9*); especially personal experience will obtain its importance in the future: In nearly two thirds of the *personal experience* assessments (64 percent) no decline or increase was assessed for the respective job profile. However, there are also partly very heterogeneous, as both declines (14 percent) and increases (22 percent) are predicted in the other assessments. The other skills will clearly increase in importance, which specifically applies to *adapt to change*, where 7 of 10 assessments predict required Master or Expert skill levels in the future. 54 percent of the assessments included an increase by one point, 10 percent an increase by two or more points. This corresponds to the higher importance of learning and teaching skills (see social skills). The overall level of needed personal skills will grow from 2.2 to 2.7.

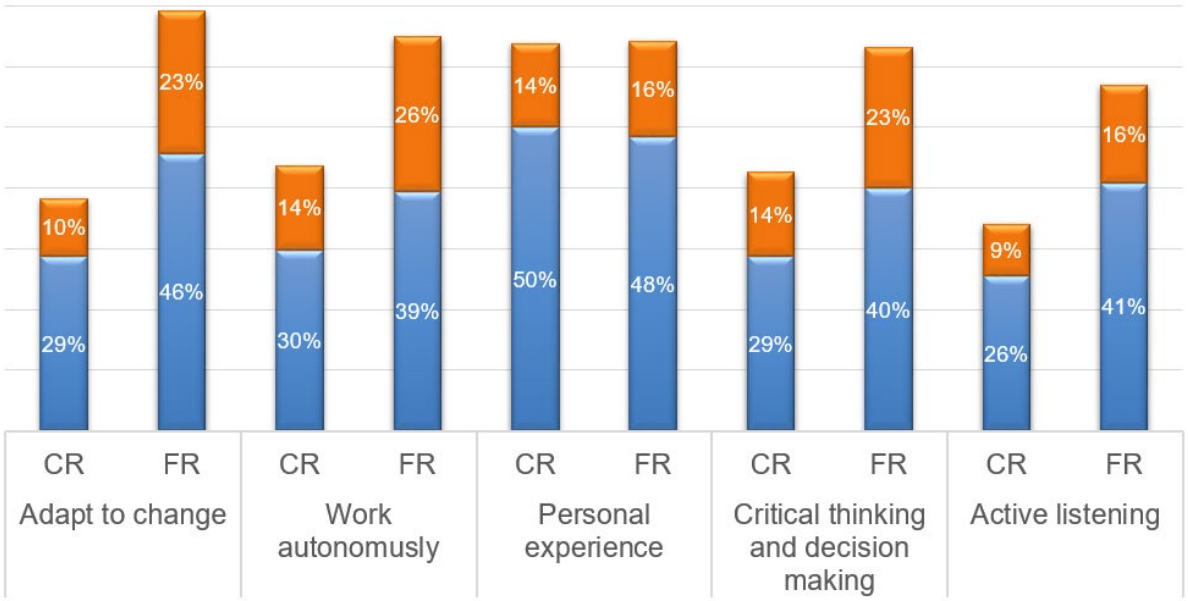


Figure 9: The need for different personal skills on Expert and Master Level now and in the near future (within 3 years) across all job profiles (combined frequencies).

Methodological skills

As with social and personal skills, it can be said that many methodological skills are already quite important today and their relevance will only increase slightly in the future (see *Figure 10*). This is especially true for *Basic numeracy and communication* as well as *Advanced literacy* where in 65 respectively 72 percent of the assessment no change in the needed skill level was determined.

However, skills related to processing information will receive a major up boost: *Quantitative and statistical skills*, but also *complex information processing and interpretation* as well as *basic data input and processing* will be more important in the future. For these categories, still in a slight majority of the cases no change in skills needs was forecasted; but at least in between 46 and 47 percent of the assessments an increase by one or even more scale steps was registered.

The overall importance of methodological skill will rise from 2.0 to 2.5.

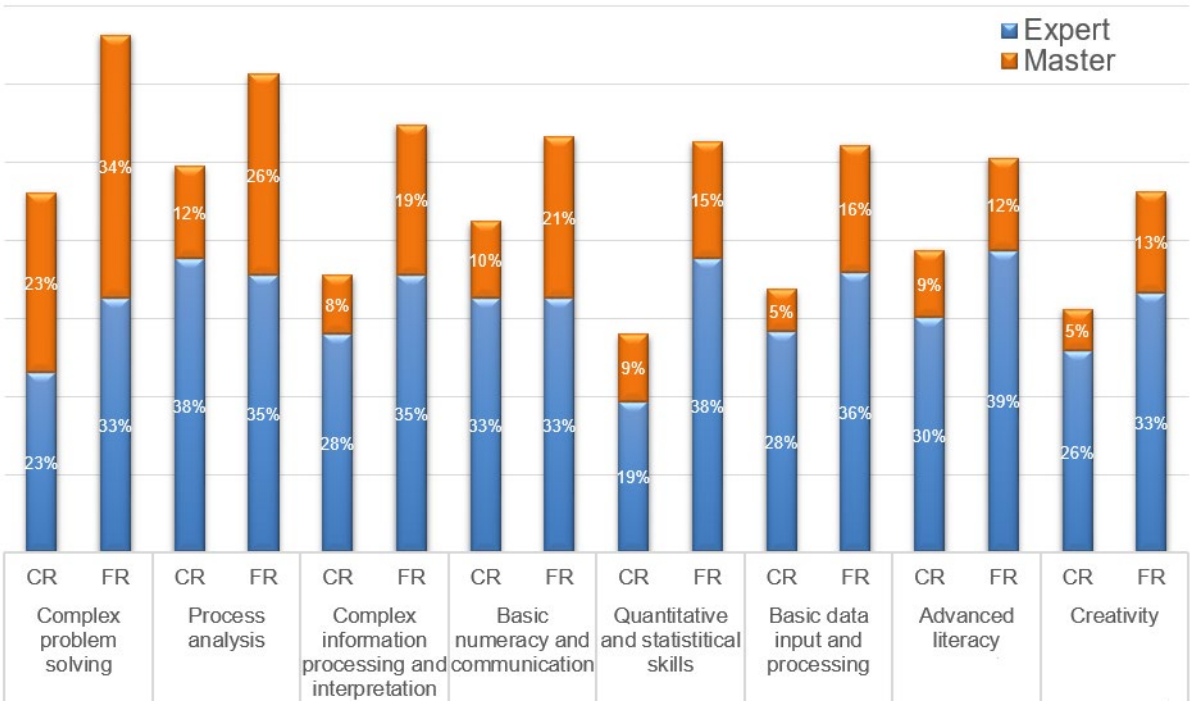


Figure 10: The need for different methodological skills on Expert and Master Level now and in the near future (within 3 years) across all job profiles (combined frequencies).

2.2.2.3 Job profiles and skill needs

The previous chapters gave a short overview on the relevance of the different concrete skills across all job profiles. *Figure 11* gives a detailed look on the differences between the job profiles in the six main skill categories.

One of the most basic findings is that the different job profiles require very different levels of skills in general. The job profiles *Metallurgical manager* as well as the supervisors (*Production supervisor* and *Production engineer supervisor*) and the engineers (*process engineer, maintenance and repair engineer*) apparently (and not really surprisingly) require a comparable high level of skills: Almost all required skill levels in the future and in the present are above the average of all job profiles taken together. Opposite to that are both the operator profiles (*Metal processing plant operator, Metal working tool setters and operators*), the *Industrial electrician* and (particularly) the *Factory Hand* profile which require a lower overall level of skills. Much speaks in favor to call the latter group the **technical oriented job profiles** and the first group the **non-technical oriented job profiles**. This seems reasonable when looking at the relevance of technical skills in these job profiles in the future: Whereas within the technical-oriented job profiles the technical skills are the most important ones, i.e no other skills have a higher relevance within these profiles, these skills play subordinated roles within the non-technical oriented job profiles where they are the 4th, 5th or 6th most important skills. Often they are also the only skills which are only needed on a below-average level within these job profiles.

There are few further more characteristic differences between the job profiles: Within the non-technical-oriented jobs (except the *Production supervisor* job profile), methodological skills seem to play a more important role. Other skills as personal skills are very much transversal and are required within all job profiles to the same extent compared to the generally required level of skills. Social skills are required to a moderate degree in all job profiles, but play especially a distinct role within the *Metallurgical Manager* profile and the *Production supervisor* profile. Digital and Green skills mostly play a more or less subordinated to moderate role within the job profiles (now and in the future), but seem to have a special meaning for single job profiles; e.g. Green skills seem to play a special role for the *Process engineering supervisor* profile, whereas digital skills are thought to play a distinct role within the *Industrial electrician* job profile in the future.

With regards to future developments the degree of growth is quite diverse for the different skill categories. It is obvious that technical skills will not be largely growing in the future: The steel companies already seem to have a proper level of skills here which will only gradually grow within the next years. The other way around, Digital and Green Skills will become much more important in the most of the job profiles. The only exception are the Maintenance and repair engineer for green skills as well as the *Factory Hand* and the *Metal working tool setters and operators* profile for digital skills.

In general, it is also interesting to see that the growth in skill needs does not affect all job profiles to the same extent and seem to be concentrated on a part of the more high-skilled job profiles, whereas a part of the lower-skilled (technical) job profiles like the Factory Hand and the Industrial Electrician profile will only be developed to low degree. This seem to entail the danger of a growing gap between certain job profiles and also impeding the upskilling of certain kind of occupations. However, this could be a potential contradiction to political goals related to employability, inclusion and job stability.

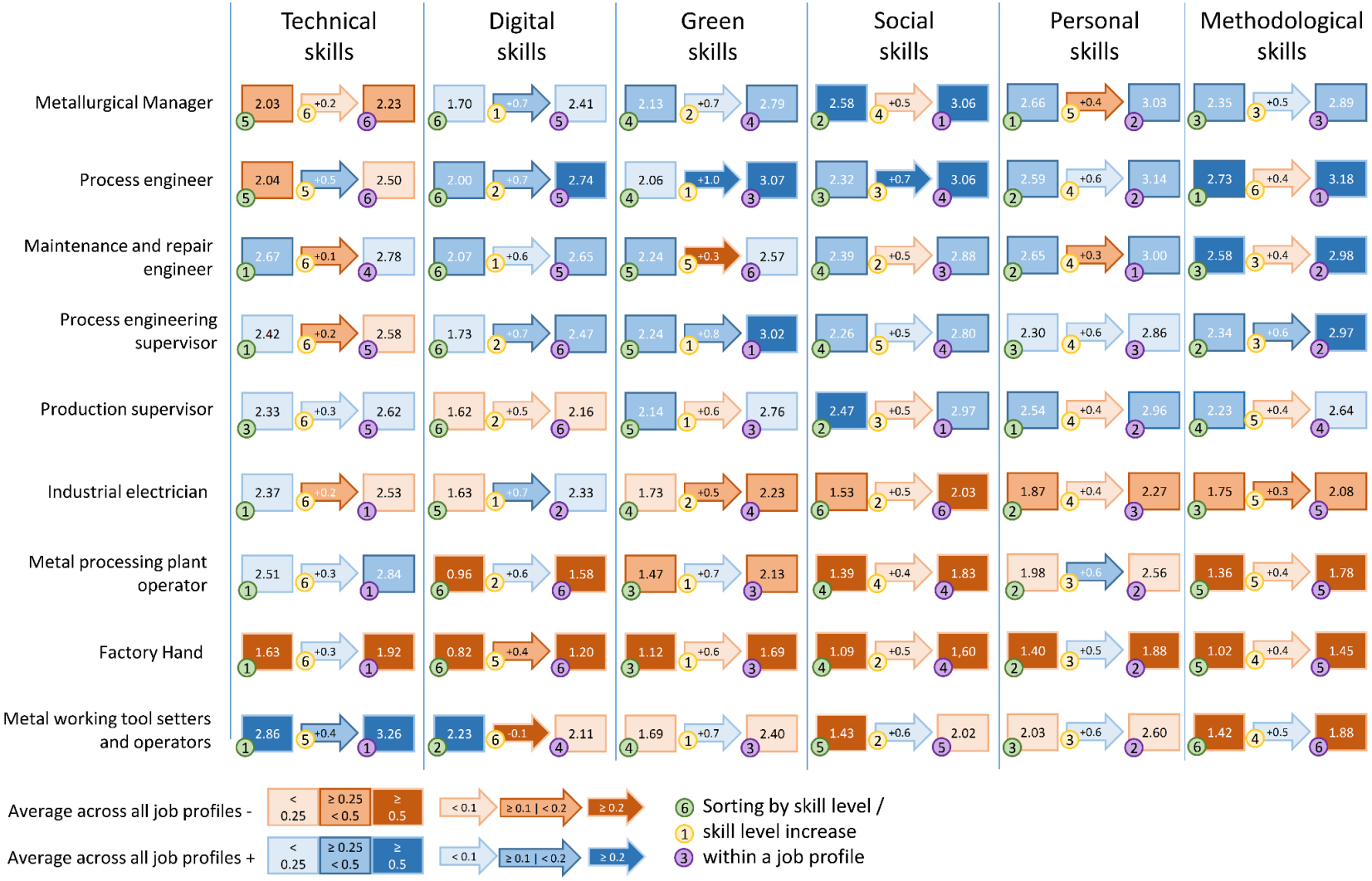


Figure 11: Needs for different skills, summarised for each job profile and each (broad) skill category. Used 5-level scale was interpreted metrically. Colours indicate the distance of each value to the average value across all job profiles (for which the number of participants were harmonised, giving each job profile the same weight). The number in the circle indicate the rank of the respective skill level or increase of needed skill level within one job profile. Rank 1 represents the strongest skill level increase / skill level within this job profile

3. The European STEEL SECTOR Profiles Family Tree

3.1 The Objective and Results

Stakeholders and experts consider that a job profile family tree is a valid view which can be used to facilitate navigation and demonstrate relationships between job profiles. It also gives us a clear idea about the organizational structure that the family belongs to.

The job profile family concept is principally analogous to a human family where characteristics from one generation pass to the next but are also incorporated with new characteristics. [21] We can think it as viewing a subject from a distance through a camera lens and making an outline of that subject. As we gradually focus the lens we can see progressively and more sharply and can better understand the detail of the subject we are viewing. Likewise, the family tree provides us a distant viewpoint with a clear outline but with inner details that are intentionally generalized. During the development of job profiles, the family provides us an additional perspective and the option to modify content and to incorporate detailed granularity to meet specific requirements while maintaining the original profile outline. [21] Thus, utilizing the family tree, the profiles may be used for reference or alternatively as a base to develop further profile levels. [21]

In the first version of European Steel Sector Professional Role Profiles (See Chapter 4) the concept of a STEEL SECTOR family tree was introduced. Therefore, as the first step, professional role profiles were elaborated in a family tree for all the production and maintenance functions in steel companies. The final version of this family tree aimed to be used as reference for the whole steel sector. During the development of the family tree, the company's (Sidenor in this case) management team and Human Resources team needed to work together, collaborating with the corresponding departments of the company in order to generate the first level families and identify the second level role profiles.

For the STEEL SECTOR, there is a big complexity when trying to define the Profiles Family Tree. Structured from two production processes "Blast furnace" and "Electric arc furnace", products could be different depending on the markets to which they are aimed and the final application. Downstream, twenty-six main STEEL SECTOR Profile Level 1 families (Figure 12) can be found and currently more than 200 profiles will intend to reflect the European STEEL SECTOR Profile Family Tree. (Please see ANNEX I). This concept allows to adapt the core components of the level 2 profiles as needed to the user-generated profiles with higher level of detail. For example, (see Figure 13) 'melting shop process manager', 'EAF production manager' and 'continious casting production manager' role profiles have the same core components since they belong to the same family and same hierarchical order. If we want to create another job profile in this hierarchical order (a manager job profile in the melting shop department), this new profile will have these same core components with the mentioned job profiles; only specific details will be added to the profile along with these components. Therefore, it will highly simplify the process.

Figure 12: European STEEL SECTOR Professional Role Profiles: twenty-six families (level 1) at the top of the European STEEL SECTOR Profile Family Tree

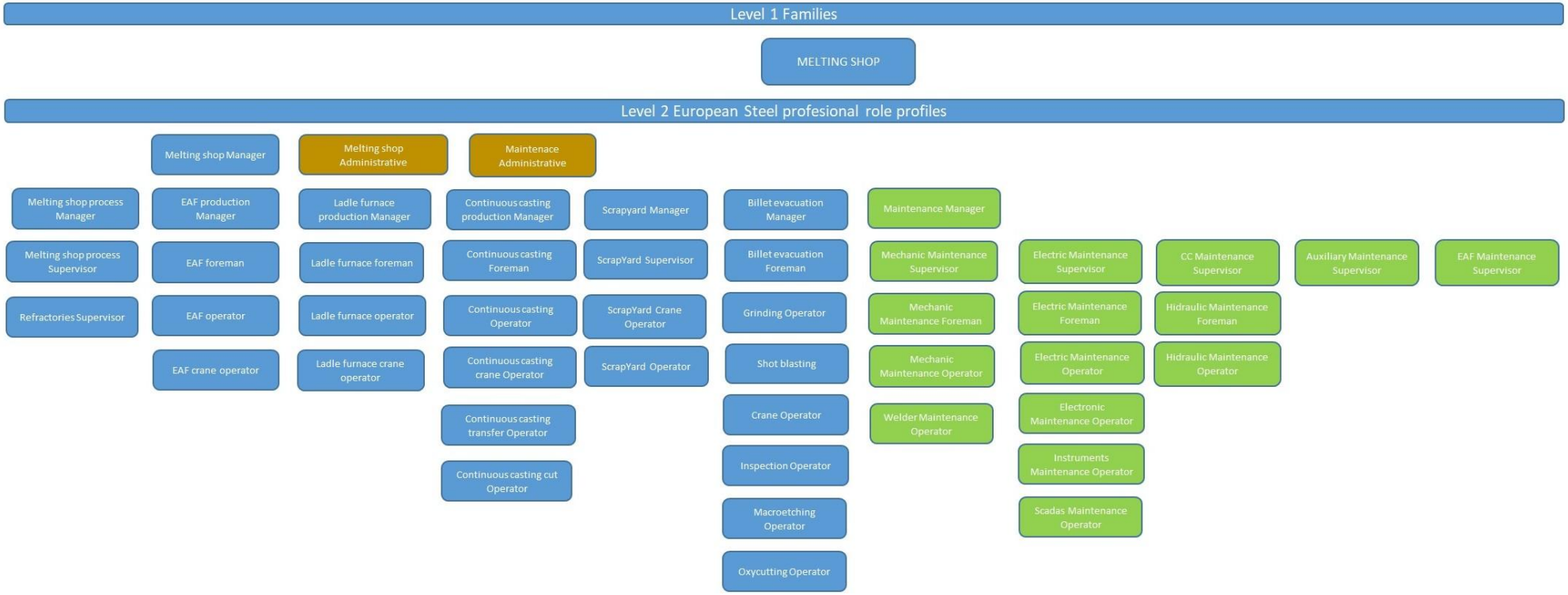


Figure 13: European STEEL SECTOR Professional Role Profiles: profiles (level 2) of Melting Shop Family at the downstream of the European STEEL SECTOR Profile Family

There are a huge range of different job titles across the Steel Sector profession and they are created for a variety of purposes including attracting new recruits and providing recognition for organisation loyalty through the promotion and construction of enhanced job titles (see ANNEX I). Jobs are unique but a similar title can be used to describe widely different jobs, conversely similar jobs can be described by different titles. This can be confusing and prevent clear understanding between different actors and stakeholders of the job described and its associated tasks and responsibilities. Therefore, a standardisation, reduction and merger of similar profiles in the whole job family tree is required. We need to reduce the number of job profiles in the family tree by finding common ground between as many of them as possible and merging them.

The family tree approach is highly useful from a sectorial-organizational point of view; nevertheless, it is unnecessarily complicated for VET framework providers during the generation of lifelong learning training programs.

In order to cope with this complexity and achieve effective occupation and job profiles we need to generate a common ground for the profile database, from the point of view of both companies and VET trainers. Occupation and skills profiles should combine the company and training perspectives. Thus, this common ground would allow to simplify and consolidate the Professional Role Profiles in the STEEL SECTOR.

3.2 The ESCO approach

As the European STEEL SECTOR Profile Family Tree provides a structured information during the generation of the occupation and job profiles that will be used as a complemetary information for WP4 and also for the Blueprint development (WP5), it was agreed by the ESSA partners that in order to create competent occupation & skill profiles, the European STEEL SECTOR Profile Family Tree needed to be consolidated and simplified. In this way, it would ensure a constant view on the changing skills needs in the STEEL SECTOR, linked to the main drivers, emerging technologies and trends that are influencing the change.

The STEEL SECTOR Profile Family Tree, completed with the contribution of the partners, has been evaluated and consolidated in order to reflect the whole families and profiles covering the European Steel Industry. The ESCO database profile has been used for comparison and consolidation.

In order to explain the ESCO approach, we need to give a brief definition of ESCO; ESCO is a European Commission sponsored EU-initiative that provides a common European classification of Skills, Competences, Qualifications and Occupations. [22] In other words, it's as a dictionary, describing, identifying and classifying professional occupations, skills, and qualifications relevant for the labour market and education and training. And it is directly linked to the International Standard Classification of Occupations (ISCO) which is classification of occupation groups managed by the International Labour Organization (ILO), since the information and data in ESCO is based on an original work published by the ILO under the title "International Standard Classification of Occupations", ISCO-08.

ESCO is designed to improve communication between the education and training sector and the European labour market and is structured in three interrelated data pillars, Occupations, Skills and Qualifications.

According to the European Qualifications Framework (EQF) [23] and European e-Competence Framework (e-CF) [24], skills, knowledge and attitudes are components of competences. Competences are therefore defined as the ability to use skills, knowledge and attitudes to achieve results. Skills and knowledge are mainly regarded separately,

even though some sources define skills as the ability to apply knowledge, describing skills as a synonym for competences.

Skills: In general, skills can be defined as capabilities to complete a task.

ESCO applies the same definition of "skill" as the European Qualifications Framework (EQF) and Cedefop: "skill means the ability to apply knowledge and use know-how to complete tasks and solve problems". Skills can be described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments).

Knowledge: According to the e-CF, knowledge represents the set of know-what, such as programming languages or design tools, while the EQF and Cedefop describes knowledge (theoretical and factual) as the assimilation of information (body of facts, theories, practices and principles) through learning.

ESCO applies the same definition for knowledge as the European Qualifications Framework (EQF). According to this, "knowledge means the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of work or study. Both skills and competences rely on factual and theoretical knowledge, the difference lies in the way this knowledge is applied and being put into use. [26]

Attitude: With skills and knowledge being the main components of competences, attitudes can be regarded as the glue that keeps them together. Attitudes are described as the cognitive and relational capacity as well as the motivation to do something.

Competences: are defined as demonstrated ability to apply knowledge, skills and attitudes for achieving observable results in e-CF.

ESCO applies the same definition of "competence" as the European Qualification Framework (EQF): "competence means the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development". They are described in terms of responsibility and autonomy. [27]

Learning outcomes: According to Cedefop, learning outcomes state what a learner is expected to know, be able to do and understand at the end of a learning process or sequence. The way such outcomes are defined and written orients teaching and learning, and influences the quality and relevance of education and training. The way learning outcomes are defined and written matters to individual learners, the labour market and society in general. [28,29]

Qualifications: Qualifications are understood as "the formal outcome of an assessment and validation process, which is obtained when a competent body determines that an individual has achieved learning outcomes to given standards". [30]

Tasks (functions): Are defined as the actions necessary to turn a set of inputs into valuable outputs. Tasks can be considered as the content of jobs. In essence: Tasks are what needs to be done and skills define the capacity to do them.

In ESCO database, each occupation comes with an occupational profile, in which the knowledge, skills and competences that are relevant for the respective occupation are listed. ESCO's skills pillar contains knowledge, skills and competences.

3.3 The potential equivalence between ESCO occupations and Steel Sector job profiles

For ease of reference, an example relationship map between ESCO Occupation titles and STEEL SECTOR Professional Profiles (generated by ESSA) in both directions is provided in Table 2.

It is important to note that the relationship between the two structures does not represent an equivalence but could be the starting point to create such equivalence between ESCO and the titles in the STEEL SECTOR.

The Steel Sector Professional Role Profiles can be defined by three groups that take into account the main manufacturing processes of steel manufacturing companies: i) liquid steel production and semi product production, ii) rolling mill and iii) operations to obtain the finished product.

The Professional Role Profiles are the base for the profiles description and definition of the needed skills for those profiles. The profiles should be understandable to both companies and VET system institutions. Therefore, it has been decided to take the occupations defined by ESCO database related with the STEEL SECTOR as the basis for the profile description.

One of the issues that arise is that not all the STEEL SECTOR titles, or profiles are covered by the ESCO occupations database and new occupations must be created during the profile definition task. In this way, the work developed during the compilation of the profiles in the STEEL SECTOR industry could feed into the ESCO database, enriching it with new occupations and descriptions. To align the ESSA profile description with the ESCO database a joint meeting took place to coordinate a common development process. As a result of the meeting, ESCO and ESSA project & WP3 leaders concluded that the data from the ESSA job profile descriptions will be integrated in ESCO database when needed. It is foreseen not to elaborate a standalone database for the steel industry but to integrate it in existing databases like ESCO (see Deliverable D3.1).

Furthermore, VET system institutions in Europe define their curricula aiming for general or particular job profiles, not only focused on the Steel Sector but onto other industrial sectors, making the job of finding a general correlation a hard task and preventing for the definition of standard rules between the VET systems across Europe.

It’s at this point that arises the concept of “learning outcomes” as the link between the needs of the industry regarding the training of its future workers and the offer of VET institutions regarding the training of their students.

Table 2: Relationship map between ESCO Occupation titles and STEEL SECTOR Professional Role Profiles, defined by ISCO group numbers.

MELTING SHOP		
iscoGroup	Ocupation ESCO	STEEL SECTOR ROLE PROFILES
1219	department manager	Blast Furnace Manager
2141	process engineer	Blast Furnaces Process technician
3119	process engineering technician	Blast Furnaces Process professional
1321	industrial production manager	Blast Furnaces Production Manager
3122	machine operator supervisor	Blast Furnaces foreman
3135	metal furnace operator	Blast Furnaces Operator
	machine operator	Blast Furnaces Joint operator
8343	mobile crane operator	Loads and unloads operator
	Refractories Coordinator	Blast Furnaces refractory lining coordinator
	Refractories Supervisor	Blast furnace refractory lining Supervisor
	Refractories Operator	Blast furnace refractory lining foreman
		Iron Pig coordinator
3122	machine operator supervisor	Iron Pig desulphurisation Supervisor
	machine operator	Iron Pig desulphurisation operator
	mobile device operator	hot-metal transfer car overturning operator
1219	department manager	Melting shop Manager
2141	process engineer	Melting shop process Manager
3119	process engineering technician	Melting shop process Supervisor
1321	industrial production manager	EAF production Manager
3122	machine operator supervisor	EAF foreman
3135	metal furnace operator	EAF operator
8343	mobile crane operator	EAF crane operator
	Refractories Supervisor	Refractories Supervisor
1219	department manager	SteelWorks Manager
1321	industrial production manager	Converter Production Manager
3122	machine operator supervisor	Converter Shift Manager
	machine operator	Converter Operator
3122	machine operator supervisor	Blowing supervisor
	machine operator	Transfer pig iron Operator
	machine operator	Torpedo tipping Operator
3122	machine operator supervisor	Oxigen converter gas recovery system Supervisor
	machine operator	Oxigen converter gas recovery system Operator
1321	industrial production manager	Secondary Metallurgy & Ladle Production Manager
3122	machine operator supervisor	Secondary Metallurgy Supervisor
	Secondary Metallurgy operator	Secondary Metallurgy operator
	Refractories Supervisor	Ladle & Refractory Supervisor
	Refractories Operator	Ladle Preparation Operator
1321	industrial production manager	Continuous casting Production Manager
3122	machine operator supervisor	Continuous casting Shift Manager
3122	machine operator supervisor	Continuous casting Supervisor
8121	casting machine operator	Continuous casting operator
7223	oxy fuel burning machine operator	Oxycutting Operator
		Slabyard and forwarding Manager
		Slab yard and forwarding Shift Manager
		Slabyard and forwarding Supervisor
		Slabyard Operator
	product engineering technician	Solid Steel Product Technician
1321	industrial production manager	Ladle furnace production Manager
3122	machine operator supervisor	Ladle furnace foreman
		Ladle furnace operator
8343	production plant crane operator	Ladle furnace crane operator
1321	industrial production manager	Continuous casting production Manager
		Continuous casting Foreman
8121	casting machine operator	Continuous casting Operator
		Continuous casting transfer Operator
7223	oxy fuel burning machine operator	Oxycutting Operator
8343	mobile crane operator	Crane Operator
		Billet evacuation Manager
		Billet evacuation Foreman
		Grinding Operator
		Shot blasting Operator
		Inspection Operator
		Macroetching Operator
7223	oxy fuel burning machine operator	Oxycutting Operator
8343	mobile crane operator	Crane Operator

Blast furnace process steel production

Electric Arc furnace process steel production

xxxx ESCO existing occupations

xxxx Not existing occupations to be added to ESCO database

In order to compherend the interconnection between ISCO, ESCO and the work done in ESSA, the following figure (Figure 14) is shown as an example. The ESSA Occupation represents the specific interest of the steel industry.

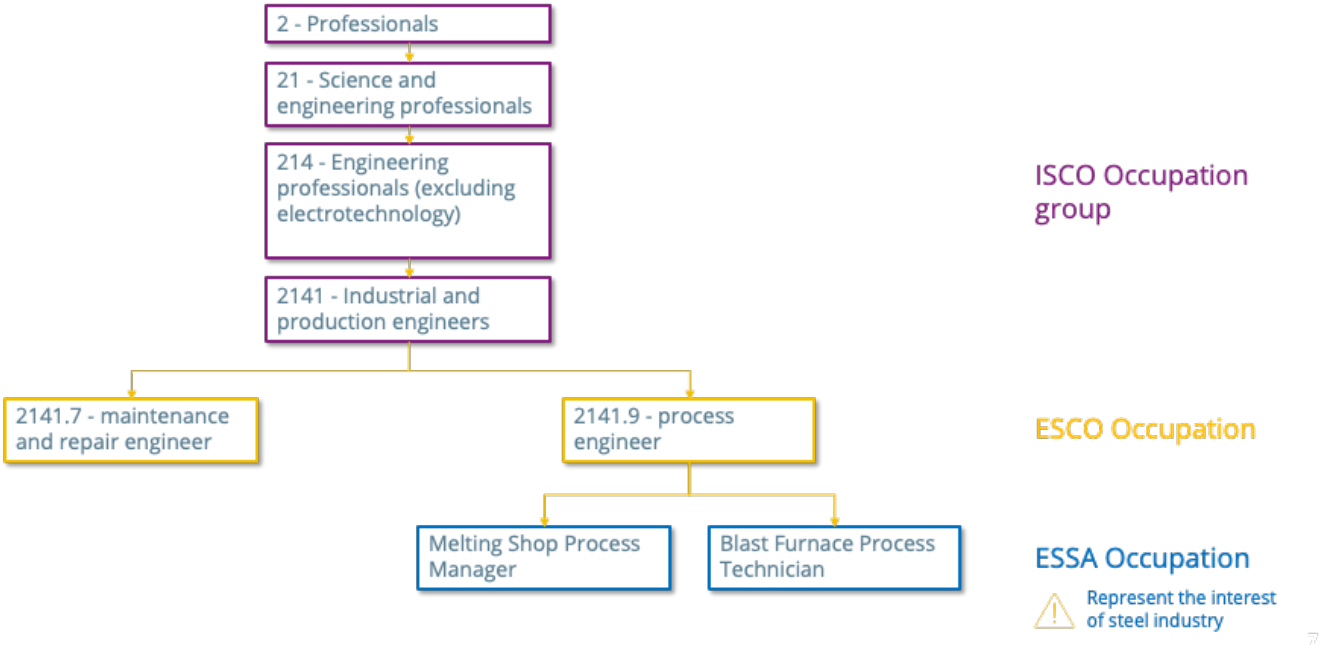


Figure 14 Interconnection between ISCO, ESCO and the work done in ESSA

4. The European Steel Sector Professional Role Profiles description

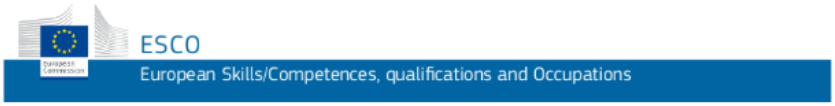
4.1 The Generation of the Template and the Objectives

The potentiality for the equivalence between ESCO and the titles in the STEEL SECTOR opens the door to the automatization of the description of the European Steel Sector Professional Role Profiles taking the ESCO description of occupations as the basis for a full description of the Steel Sector Professional Role Profiles. As an example, the ESCO "mobile crane operator" description has been taken. (Figure 14) ESCO gives a description of this occupation that could match with the mission of the Profile "crane operator" in the STEEL SECTOR industry with only small modifications.

ESCO shows also as a good alternative to match the Essential and Optional skills and competences and Knowledge for the Steel Sector Professional Role Profiles.

In ESCO database, each occupation comes with an occupational profile, in which the knowledge, skills and competences that are relevant for the respective occupation are listed. As demonstrated in Figure 15, the profile includes not only needed skills and knowledge but also (1) the ISCO number of the profile, which can be called as an international code of the occupation for the International Standard Classification of Occupations (ISCO), (2) the description of the profile, (3) alternative labels, (4) the hierarchical order of the occupational groups (In this case, the job profile 'mobile crane operator' belongs to the 'crane, hoist and related plant operators' group, which is a part of the bigger occupation group 'mobile plant operators', and so on),(5) a web link to ESCO's webpage where we can find all the introduced data related to the job profile.

Among all this data, 'ISCO number', 'profile description' and 'tasks (as functions) from ESCO occupational profiles can be integrated into the "steel professional role profile description" template. Since in ESCO profiles "competence", "skill" and "task´" are usually referred as same concepts and there is no clear distinction between them , we modified these concepts and generated profiles based on "TASKS" and "SKILLS" in order to achieve a more common ground and reduce the complexity. In addition, the "European ICT Professional Role Profiles" generated by European Committee for Standardization (CEN) [21] was taken as an example while creating the description template: 'summary statement', 'mission' and 'task(s)' of the job profile was also incorporated into the profile description.



mobile crane operator

Discuss this topic in the Online Forum

Code

8343.3

Description

Mobile crane operators work with a variety of crane types that can be moved easily around the road, rail and water. Mobile cranes are often mounted on trucks.

Alternative label

mini crane driver
mini crane operator
operator specialised in mobile crane
lorry-mounted crane operator
compact crane operator
mobile crane driver
compact crane driver
mobile crane operators
bottom cat operator
lorry-mounted crane driver

Regulatory aspect

To see if and how this occupation is regulated in EU Member States, EEA countries or Switzerland please consult the Regulated Professions Database of the Commission. Regulated Professions Database:
http://ec.europa.eu/growth/single-market/services/free-movement-professionals/qualifications-recognition_en

Hierarchy

8 - Plant and machine operators and assemblers
83 - Drivers and mobile plant operators
834 - Mobile plant operators
8343 - Crane, hoist and related plant operators
mobile crane operator

Essential skills and competences

drive mobile heavy construction equipment
follow health and safety procedures in construction
inspect construction sites
interpret 2D plans
interpret 3D plans
keep heavy construction equipment in good condition
operate GPS systems
operate mobile crane
react to events in time-critical environments
rig loads
secure heavy construction equipment
set up crane
use safety equipment in construction
work ergonomically

Essential Knowledge

crane load charts
mechanical systems
mechanics

Optional skills and competences

follow safety procedures when working at heights
guide operation of heavy construction equipment
keep personal administration
keep records of work progress
operate heavy construction machinery without supervision
perform minor repairs to equipment
process incoming construction supplies
set up temporary construction site infrastructure
set up tower crane
test soil load bearing capacity
transport construction supplies
use remote control equipment
work in a construction team

Optional Knowledge

electricity

Status

released

Concept URI

http://data.europa.eu/esco/occupation/1f2b8092-1787-4ef4-9282-cf81ce4b4d76

Figure 15: ESCO "mobile crane operator" occupational profile description

The potential equivalence between ESCO and the titles in the STEEL SECTOR (Table 2) also enabled us to generate an automated database for the description of the European Steel Sector Professional Role Profiles taking the ESCO description of occupations as the main data source. Using the ESCO database for Occupations, DEUSTO University has developed a software that will allow automating the description of the different profiles of the STEEL SECTOR.

The result of this first description of the profiles are continuously being validated and refined through the knowledge of the Steel Sector industrial partners that are collaborating on the WP3. The aim of this step was to create a common database of professional profiles related with steel sector, which is interactive for continuous updating. It was accomplished through data integration and automation processes. The database is delivered under the name of "Deliverable 3.1 Database of the Professional Profiles".

The future plan is making the database interactive, in other words, to be able to introduce the current /future skills and the current/ future proficiency levels that are not present in ESCO database, interactively to the ESCO database with the support of ESCO. Therefore, the aim is not only to be able to

The European Steel Sector Professional Role Profiles are constructed consistently to provide a common template. A standard template makes it easier for users to compare different profiles and provide a fast start for developing new profiles or contributing to designing new job descriptions.

The template was designed to respond to the questions included in Table 3, to assist users in communicating the purpose and potential application of the profiles within their organization.

Table 3: the questions leading to the purpose and potential application of the template descriptions

Question	Template Descriptor
What is the role about?	***Title*** *Formed of a few words, the title offers a common name for the role*
What is done in this role?	***Summary statement*** *Formed of a single sentence, this summary presents a brief, concise description of the role.*
Why is this role needed?	***Mission*** *Within a maximum of three sentences this element describes the rational and context of the role within the organisation.*
Which actions should be performed?	***Main tasks*** *A list of inputs that can be considered as the content of jobs.*
What skills are required?	***Technical & transversal skills*** *Each defined by a proficiency level, provide the overview of the skills, knowledge and attitudes required of the role.*

The main principle applied to constructing the profiles was to focus on the most essential characteristics that accurately represent the profile and effectively differentiate one profile from another.

The European STEEL SECTOR Professional Role Profiles offer a template that is of generic value and can in principle be applied to any sector. Sharing the same format beyond sectors will contribute to increased transparency across organisations, countries and sectors. It also supports the creation of the job profiles combining STEEL SECTOR-specific roles with business and specific knowledge from other fields.

Referring to the template, each described topic may be addressed and converted to the 'language of the sector' to form the basis of a profile that will inevitably contain different content but formatted in an easy to understand structure.

A standard template like job profile description makes it easier for users to compare different profiles and provide a fast start to developing new profiles or contributing to designing new job descriptions: Adopting the structure and format of the professional profiles template but using different content to establish significantly different roles either related or even unrelated to Steel Sector is possible.

The European Steel Sector Professional Role Profiles (Figure 16) have therefore been created in a generic and simple way, in order to enable reference and use by all types of organisations, whatever their size and their structure. In consequence, the Profiles provide high level outlines of typical STEEL SECTOR Professional Roles; easy to break down to the next context specific application level, for instance job descriptions.

PROFILE TITLE	Profile Name		
Summary Statement			
Mission			
TASKS	Current	Future	
Main task/s	ESCO description	Here it should be listed which tasks are changing/modified in which way, and if any new tasks appear	
Equivalent profiles in steel sector	Equivalent STEEL SECTOR profiles		
SKILLS		Current Level	Future Level
Technical, subject related skills			
Technical	General equipment operation		
	General equipment repair and mechanical skills		
	Craft and technician skills		
	Gross motor skills and strength		
	Inspecting and monitoring skills		
SKILLS		Current Level	Future Level
Transversal skills			
Digital skills	Basic digital skills		
	Advanced data analysis and mathematical skills		
	Cybersecurity		
	Use of complex digital communication tools		
	Advanced IT skills & Programming		
Green skills	Environmental awareness		
	Energy efficiency		
	Water conservation		
	Waste reduction and waste management		
	Resource reuse/recycling		
Social skills	Advanced communication and negotiation skills		
	Interpersonal skills and empathy		
	Leadership and managing others		
	Entrepreneurship and initiative taking		
	Adaptability and continuous learning		
	Teaching and training others		
Individual, personal skills	Critical thinking & decision making		
	Personal experience		
	Adapt to change		
	Work autonomously		
	Active listening		
Methodological skills	Basic numeracy and communication		
	Basic data input and processing		
	Advanced literacy		
	Quantitative and statistical skills		
	Complex information processing and interpretation		
	Process analysis		
	Creativity		
	Complex problem solving		

0	Novice
1	Awareness/Basic Actor
2	Practitioner
3	Expert
4	Master

Figure 16: European Steel Sector Professional Role Profiles template

Each profile element is described below, in Table 4.

Table 4: Description of the elements of the professional role profile template.

PROFILE TITLE ***Define***	**Gives a commonly used name to a profile.** The names proposed for the job profiles must match the names indicated by ESCO for occupations. Profiles not described in ESCO occupations, should be defined as new names for job profiles. These new titles created for the STEEL SECTOR do not have to be in conflict with the names of ESCO occupations overlapping with existing ones.
SUMMARY STATEMENT ***Adapt from ESCO***	**Indicates the main purpose of the profile.** The purpose is to present a brief, concise understanding of the specified STEEL SECTOR Profile. It should be understandable by STEEL SECTOR professionals, STEEL SECTOR managers, Human Resource personnel and education and training institutions. The structure should consist of a short sentence (up to approximately 15 words). It should not repeat the entire STEEL SECTOR Profile name. It should provide a statement of the job's main activity. *Note:* Ensure that the statement discriminates between other profiles.
MISSION ***Adapt from ESCO or add***	**Describes the rationale of the profile.** The purpose is to specify the designated job role defined in the STEEL SECTOR Profile. It should provide the performance context of the job within an organisational structure. The following verbs *may be* used within the description or at least for structuring the thinking about how to express the mission: Guarantees, Ensures, Contributes
MAIN TASKS ***Adapt from ESCO or add***	**A list of typical tasks to be performed by the profile.** A task is an action necessary to turn a set of inputs into valuable outputs. Tasks are what needs to be done. Tasks may be associated with deadlines, resources, goals, specifications and/or the expected results; however, this depends upon the context of the task and they may be omitted, however the action must always be described. A task is defined by a short description using a verb and the objective or goal of the action. List no more than ten. Each task should contribute in defining a Profile.
SKILLS	**A list of necessary skills, technical and transversal** Some examples are provided by ESCO data base.

At this point, it would be helpful to explain the different types of skills.

4.2 ESSA WP3 skill categories

Economists, other researchers, and organizational practice experts use different definitions when discussing workforce "skills". To understand the nature and magnitude of the coming skill shift, it is useful to take a business-oriented approach to the definition.

Following this approach, we include both intrinsic abilities (for example, gross motor skills and strength, creativity, and empathy) and specific learned skills, such as those in advanced IT and programming and advanced data analysis. This will allow us to build a comprehensive view of the changing nature of workforce skills and provide a sufficient level of detail to motivate concrete actions and interventions.

After a detailed desk research and fruitful discussions among the skills development subject matter experts of ESSA project, we ended up with a set of skills across six broad categories: physical and manual, methodological, social, individual and personal, green and digital skills under two main categories: technical and transversal skills.

Within each category are more specific skills. For instance, within social skills, we include advanced communication and negotiation, interpersonal skills and empathy, leadership and managing others, entrepreneurship and initiative taking, adaptability and continuous learning, and teaching and training others. We have also separated digital skills from methodological skills, although some of the former require methodology capabilities. [6,30]

Table 5 summarizes the generated skills categories (level 1, 2 and 3). During this process, we took McKinsey [6] as a significant reference to create a new classification.

The following skills (not present at McKinsey [6]) were integrated to the table after the detailed analysis of the sector needs and internal discussion of subject matter experts of ESSA: Cybersecurity, Use of complex digital communication tools, Environmental awareness, Energy efficiency, Water conservation, Waste reduction and waste management, Resource reuse/recycling, Personal experience, Adapt to change, Work autonomously, Active listening, Advanced literacy, Process analysis, Complex problem solving.

The detailed description of the level 1, level 2 and level 3 skills categories can be found in Annex II.

Table 5: ESSA WP3 level 1, level 2 and level 3 skill categories

Level 1	Technical skills	Transversal skills				
Level 2	Physical and Manual	Digital	Green	Social	Individual/ personal	Methodological
Level 3	General equipment operation General equipment repair and mechanical skills Craft and technician skills Gross motor skills and strength Inspecting and monitoring skills	Basic digital skills Advanced data analysis and mathematical skills Cybersecurity Use of complex digital communication tools Advanced IT skills & Programming	Environmental awareness Energy efficiency Water reduction Waste reduction and management Resource reuse/ recycling	Advanced communication and negotiation skills Interpersonal skills and empathy Leadership and managing others Entrepreneurship and initiative taking Adaptability and continuous learning Teaching and training others	Critical thinking & decision making Personal experience Adapt to change Work autonomously Active listening	Basic numeracy and communication Basic data input and processing Advance literacy Quantitative and statistical skills Complex information processing and interpretation Process analysis Creativity Complex problem solving

4.5 Skills Pipeline for the Learning Outcome

The categorisation of the skills described in the previous section is necessary to create the ESSA Skills Assessment and Foresight Questionnaire; however, the general approach of this categorisation makes it difficult to connect the skills with training and education programs (developed by VET system and other training providers), which is the target analysis of WP4. For this reason, WP3,WP4 and WP5 implemented a methodology that has been called "Pipeline for the Learning Outcomes".This methodology aims to connect the general approach of the Assessment and Foresight Questionnaire and the specific descriptions needed to analyse the training and education programs. This section explains the methodology in detail.

"Learning outcomes" are defined by CEDEFOP as the statements of what a learner knows, understands and is able to do on completion of a learning process, defined in terms of knowledge, skills and competences. Education and training institutions are increasingly describing their qualifications in terms of learning outcomes following the approach adopted by the European Qualifications Framework (EQF). [32] (For more detailed information about this subject, the reader should check ESSA WP4 Deliverable 4.2: "Analysis of cross-European VET frameworks and standards for sector skills recognition" [33].) Learning outcome descriptions form part of the metadata of qualifications in ESCO. Member States or awarding bodies include information on learning outcomes when providing data on qualifications for the ESCO qualifications pillar. Learning outcomes descriptions were also used as an input during the development of the skills pillar of ESCO. [28]

The learning outcomes principle is - explicitly since 2004 - systematically promoted in the EU policy agenda for education, training and employment. The learning outcomes approach binds together important European tools developed during the last decade, notably the European Qualification Frameworks (EQF). Therefore, its application will bind our work directly to EQF. At national level, the learning outcomes form the basis on which national qualifications frameworks are built. They are increasingly influencing the definition and writing of qualifications and curricula as well as the orientation of assessment and teaching and training.

Combining functional analysis of occupations with the analysis of learning outcome descriptions ensures that the skills terminology covers use cases in both, the world of employment and of education and training. Functional analysis determines the scope of an occupation by analysing the functions, i.e. the activities expected to be performed as part of the occupation. This process allows describing the occupation, identifying the boundaries of its scope, and capturing the knowledge, skills and competences that are needed to successfully perform the functions.

On the other hand, learning outcome approach connects the world of employment (industry) and of education and training: they serve as a bridge: they can be used for talent management & recruitment purposes as well as for the development of training courses, tools and activities. In the light of all this information, the following hierarchy tree is proposed (Figure 17).

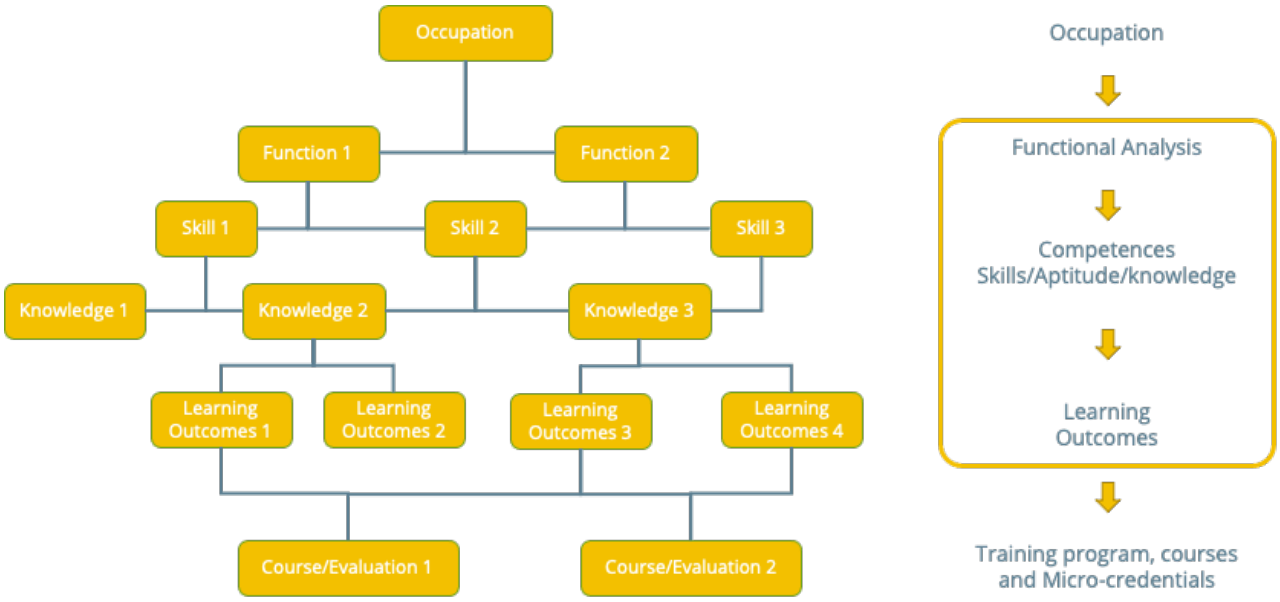


Figure 17: The hierarchy tree representing the relationship between occupation, skill, knowledge and learning outcome/objective.

In the ESCO website the functions are described as a Task for each occupation. However, it is not possible to find direct relationship between functions, competencies and learning outcomes. Therefore, the connection process is carried out by the ESSA team.

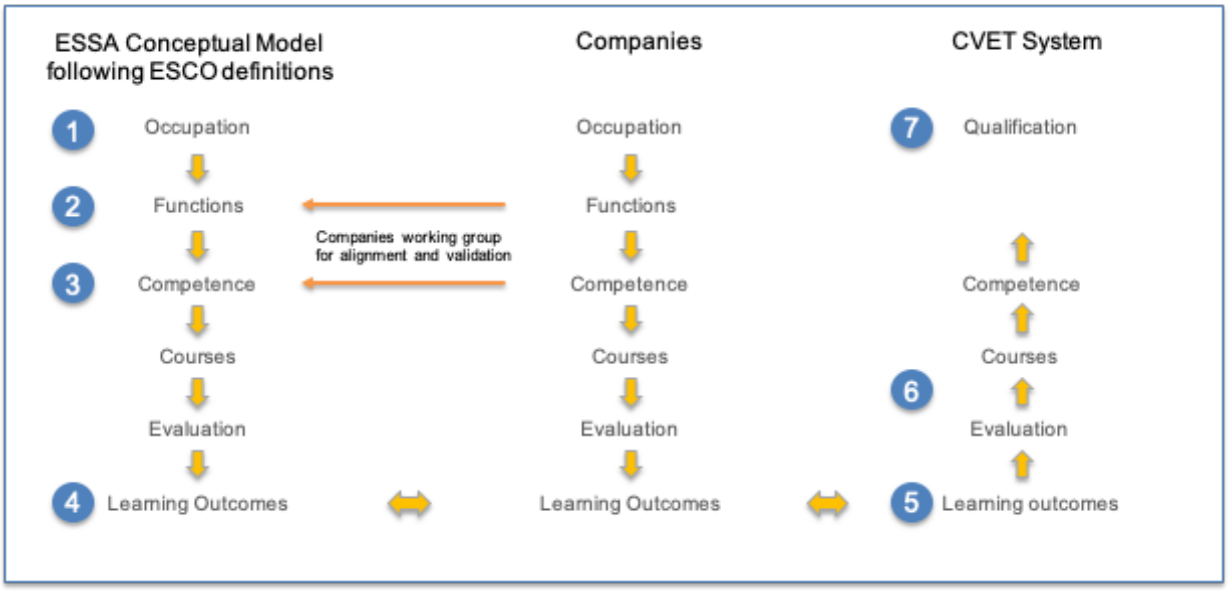


Figure 18: A representation of the pipeline..

The pipeline methodology was suggested to connect the functions (tasks) of a job profile with the skills needed to perform these tasks and then link the identified skills with their related knowledge, and then associate each knowledge with its learning outcomes. Since the training offers come with their learning outcomes, this concept is able to connect the training offer with the industry skill needs. The pipeline is created through the following steps:

1) The pipeline starts with the definition of ESSA conceptual and standard model following

the guidelines of ESCO. The occupations described in Chapter 2.2 have been selected for the pilot version to see the applicability of the methodology.

2) The tasks of each ESCO occupation are defined using "Functional Analysis Methodology". They are identified as "Functions"in the ESSA conceptual model.These functions are validated by the companies. Therefore, at this point the feedback of the companies' experts is critical.

3) Once the functions (ESCO tasks) are defined and validated, the skills defined in ESCO need to be matched with those functions. The key question will be "Which skills are needed to perform this function?" This step will allow to create different occupation in the future depending on the need of the company organizational structure. This critical step is divided in the following pipeline:

a) Each ESCO skill belonging to the selected ESCO occupation is listed.
b) The interrelationship between ESCO Skills are evaluated to short-list the skills/knowledge and to create a hierarchy tree.
c) The ESSA general skills categories used in the ESSA Skills Assessment and Foresight Questionnaire are matched with the short-listed skills.
d) The required "knowledge" is identified to carry out each ESCO skill of the occupation. If the "knowledge" is not provided by ESCO, it is created.
e) Finally the defined skills/knowledge are validated with company experts.

4) In this step, the learning outcomes for each knowledge and the evidence for each skills are generated following the CEDEFOP handbook on the definition and writing of learning outcomes. [28] For example, "Facilitating employees development plan to assure a high level employees performance", "Understanding the methodologies and procedures involved in the hiring employees" are two of the learning outcomes generated for the knowledge of "personnel management".

At the end of this process, we have a hierarchy tree with the connected functions-skills-knowledge and learning outcomes.

5) The Learning Outcomes will be matched with learning outcomes defined in the CVET (Continuing vocational education and training) systems. Through those learning outcomes the evaluation and courses as well as qualification can be identified in CVET**.

It is important to note why CVET systems were selected for this process. CVET includes any education and training activity taken after initial education and training, or after entry into working life [30]. It is aimed at improving or updating the knowledge and/or skills, acquiring new competences for a career move or retraining, and more in general, continuing personal or professional development. Therefore, it can be much more sector specific compared to IVET (Initial vocational training) systems.

The outcomes of this process will be connected with the outcomes of the training offers collected by WP6 which are defined in terms of Learning Objectives or Learning Outcomes.

In conclusion, learning outcomes will serve as a bridge connecting the work of WP3, WP4, WP5 and WP6. The long term plan is to achieve the pipelines for the 9 selected profiles and then more profiles and integrate them to the ESSA Online Training Ecosystem (ESSA OTS).

A first draft of the presented approach has been applied on the 'Metallurgic Manager (1321.1.1.7)' job profile in order to connect functions-skills-knowledge and learning outcomes. The developed hierarchy tree which is demonstrated in Figure 19, can be explored in detail in the following flow chart.

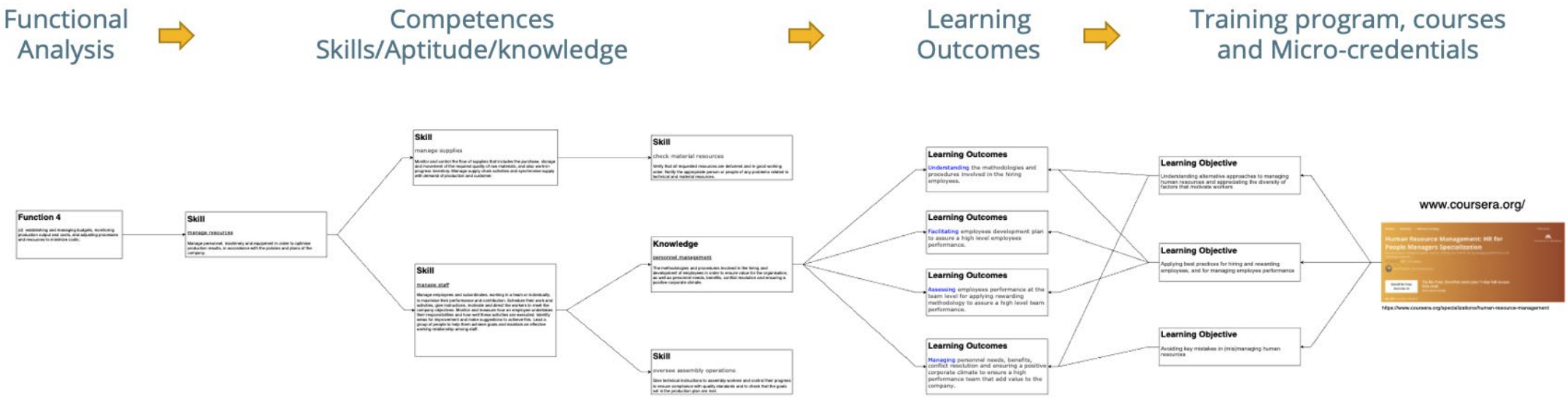


Figure 19: A representation of the hierarchical tree for the 'metallurgical manager' occupational profile, connecting ESCO functions, skills (both ESCO and ESSA), knowledge and generated learning outcomes.

4.4 Integration of the STEEL SECTOR Role Profile Descriptions into the steelHub database

The European perspective of ESSA intends to focus on the European level by an Online Training Eco-system (digital platform) and on the level of steel regions by national/regional specific Regional Training Eco-System (analog networking). Both systems are complementary and could be combined by adding specific advantages to each other (such as combining online and regional on-site analog training modules that could be integrated in a broader training program of the companies and VET providers. [34] (For more detailed information about this process, the reader should check ESSA WP5 Deliverable 5.2 Prototype of the Blueprint New Skills Agenda Steel [34].)

The steelHub as centre of the ESSA Online Training Eco-system (OTS) (Figure 20) is planned to be an exchange platform for training offers (input and output). The steelHub is engaging all the relevant and willing stakeholders (such as associations, industry, other blueprints, VET Systems, other training providers, research and development organisations, individuals) and will continuously integrate and update job profiles and competences as well as a people profile database (human resources databases). It will be a continuously updated inventory of training offers and modules curated with standard competences data base. The development of training activities and modules, including training the trainers, will be done by the different companies and training providers, coordinated by Worldsteel as a platform coordinator. Courses will be described in a comparable way and customer-oriented. General training courses but also modules for specific technology demands are developed. [33]

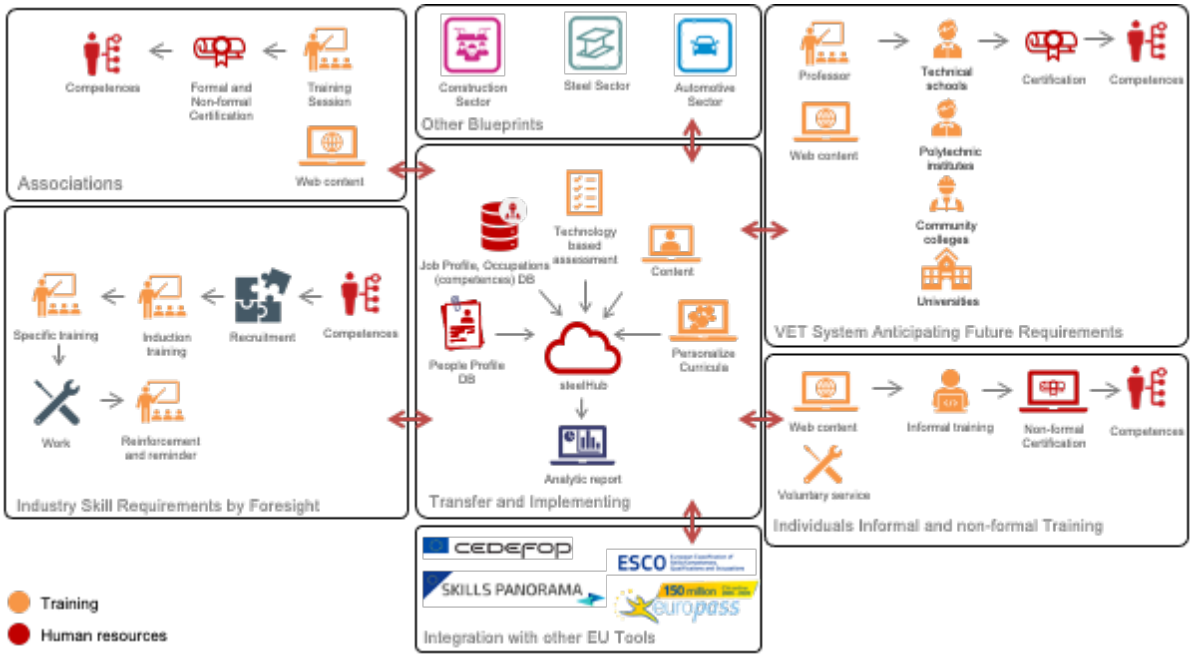


Figure 20: A representation of the ESSA Online Trainings Eco-system, where the steelHub is in centre.

Figure 20 describes the modules included into steelHub and the relationship between them. As an open platform, the steelHub training offers could be used by individuals, companies, VET providers (including VET institutions like vocational schools). Training could be integrated into VET provisions at company, national and sector level (incl. interrelation to existing EU tools like EQF, ECVET, ESCO, etc.). The centralized nature and standard protocols of communication of this collaborative platform support the development of training content in partnership between stakeholders of the training ecosystem, for example, between companies and universities, reducing the development

cost and allowing the possibility to create better, innovative and high tech learning experiences. As an online platform ESSA OTS is taking into account new possibilities of digital learning and support (social media, moodle, virtual labs, online learning, …) and workers participation and empowerment (e.g. workplace innovation, but also by using digital tools like tablets, smart phones, laptops, etc.). The main components of this central Blueprint platform are:

- "Content/Evaluation Library" for hosting training courses for up- and reskilling existing profiles.
- "Standard Occupation and Competences" module for hosting the ESSA Conceptual Model. This dynamic module will be updated regularly to include new job profiles to follow the constantly change of the world, for example in leadership, work 4.0 and train the trainers.

The following figure (Figure 21) describes the 4 stages of development setting for this platform 1st Content Library, 2nd Competence Model, 3rd Integration and 4th Monitoring and analysis.

The 1st stage of this process has been implemented and it is used by several companies and Universities.

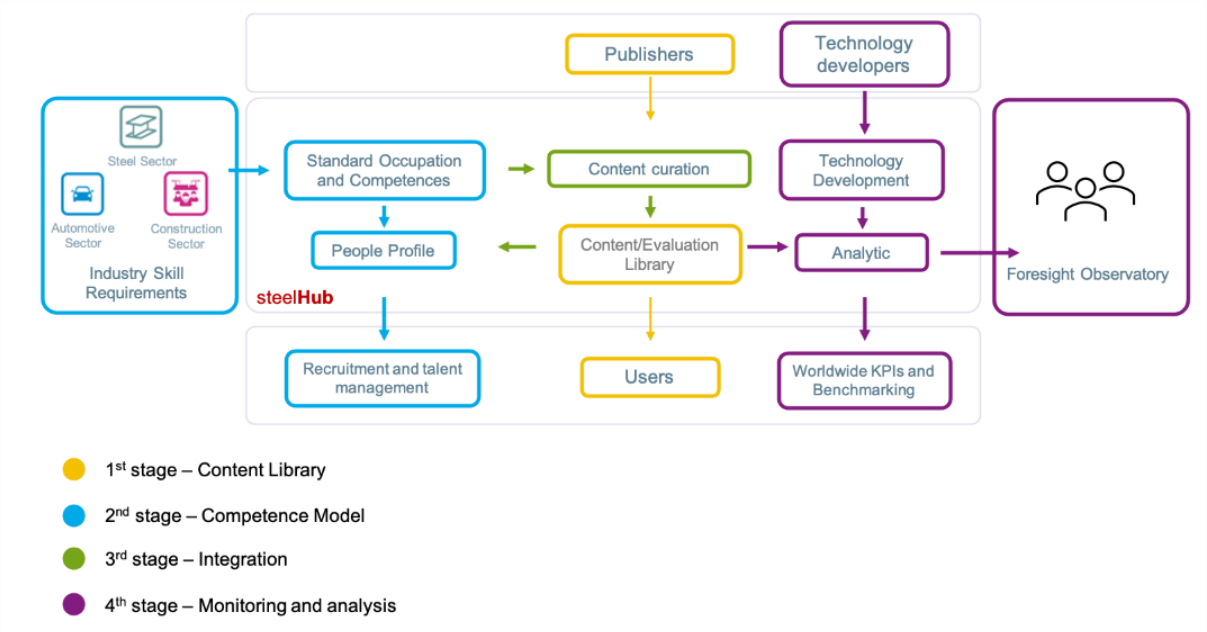
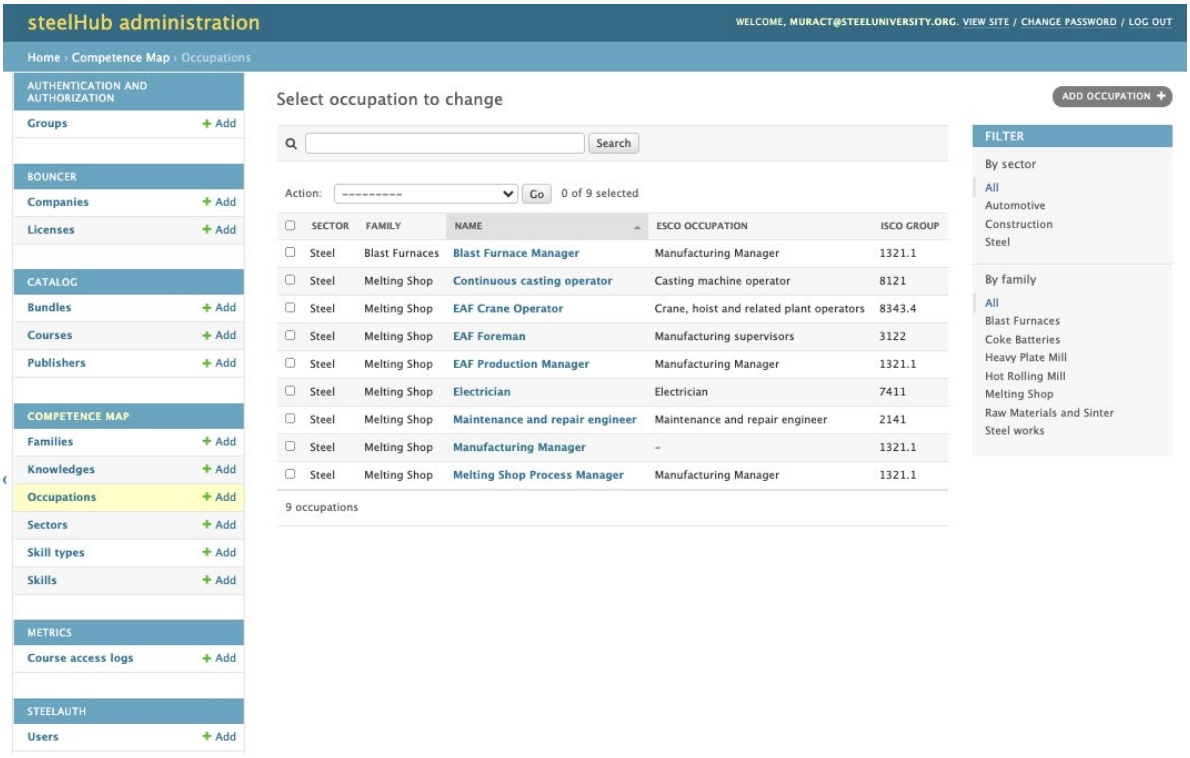


Figure 21: A representation of the ESSA Online Trainings Eco-system, where the steelHub is in centre.

The ESSA Conceptual Model described in Chapter 4.5 has been integrated into steelHub as part of the 2nd Stage of the development plan described before. The Steel Sector Professional Role Profile Description Model is integrated into the steelHub database to simplify the process for the end-users. It will facilitate the users to select the job profile they are interested in, to understand what kind of skills the profile requires, and to reach to the training offers in order to acquire the skill that they desire. In Figure 22 (a), on the example page of the steelHub online platform, we see the steel sector job profiles in the third column (blast furnace manager, continuous casting operator etc), the steel family that each profile belongs to (melting shop, blast furnaces etc.), their relevant ESCO occupation and finally ISCO group number in the other columns. Figure 22 (b),(c) and (d) show us if "EAF Production Manager" job profile is selected, we can reach all the relevant data (profile description, tasks (functions), family, ISCO number, ESSA skills categories) about the profile, which are integrated from the Professional Role Profile Description into the steelHub platform.


steelHub administration
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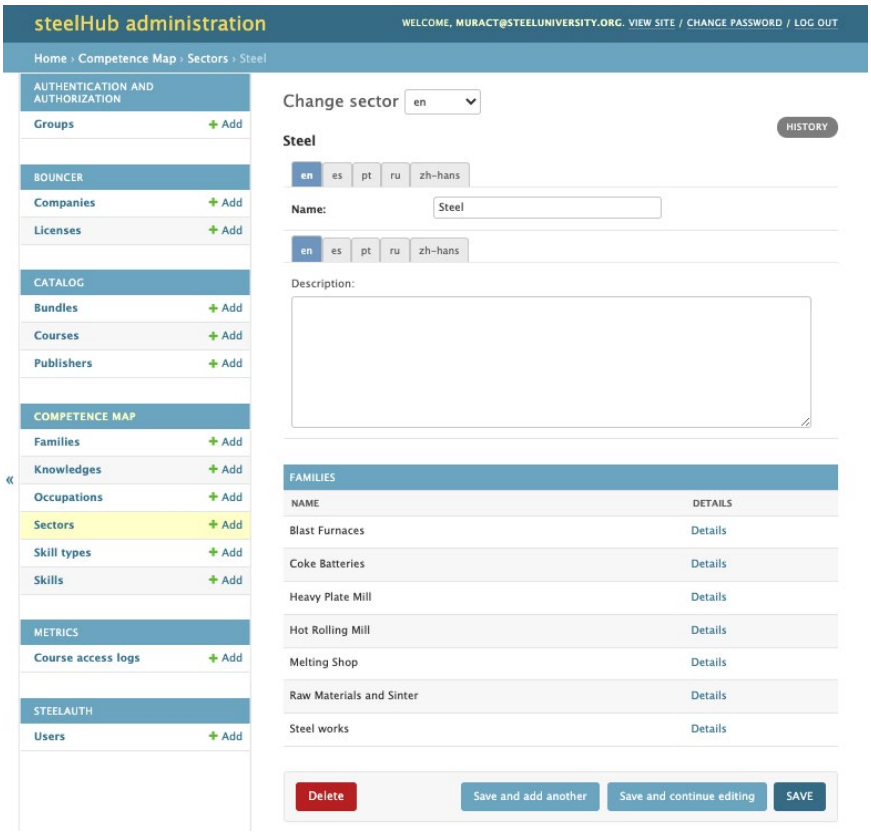
AUTHENTICATION AND AUTHORIZATION
Groups + Add
BOUNCER
Companies + Add
Licenses + Add
CATALOG
Bundles + Add
Courses + Add
Publishers + Add
COMPETENCE MAP
Families + Add
Knowledges + Add
Occupations + Add
Sectors + Add
Skill types + Add
Skills + Add
METRICS
Course access logs + Add
STEELAUTH
Users + Add
Select occupation to change
ADD OCCUPATION
Search
Action: Go 0 of 9 selected
SECTOR FAMILY NAME ESCO OCCUPATION ISCO GROUP
Steel Blast Furnaces Blast Furnace Manager Manufacturing Manager 1321.1
Steel Melting Shop Continuous casting operator Casting machine operator 8121
Steel Melting Shop EAF Crane Operator Crane, hoist and related plant operators 8343.4
Steel Melting Shop EAF Foreman Manufacturing supervisors 3122
Steel Melting Shop EAF Production Manager Manufacturing Manager 1321.1
Steel Melting Shop Electrician Electrician 7411
Steel Melting Shop Maintenance and repair engineer Maintenance and repair engineer 2141
Steel Melting Shop Manufacturing Manager - 1321.1
Steel Melting Shop Melting Shop Process Manager Manufacturing Manager 1321.1
9 occupations
FILTER
By sector
All
Automotive
Construction
Steel
By family
All
Blast Furnaces
Coke Batteries
Heavy Plate Mill
Hot Rolling Mill
Melting Shop
Raw Materials and Sinter
Steel works

(a)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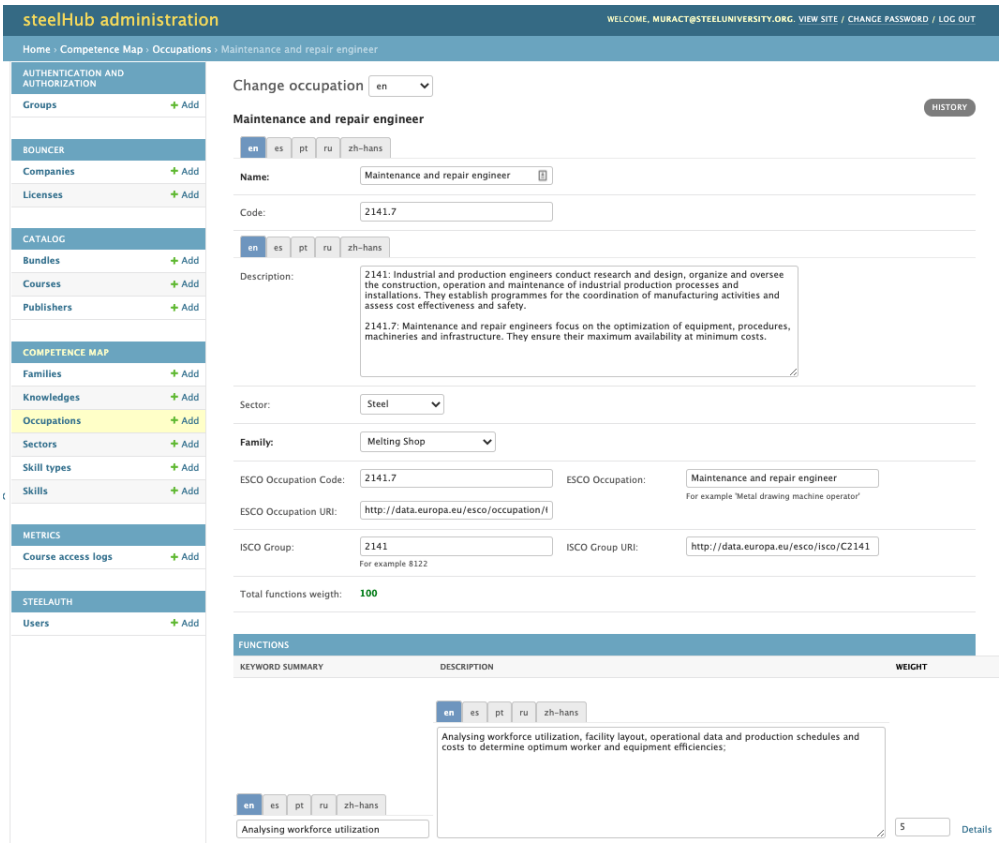
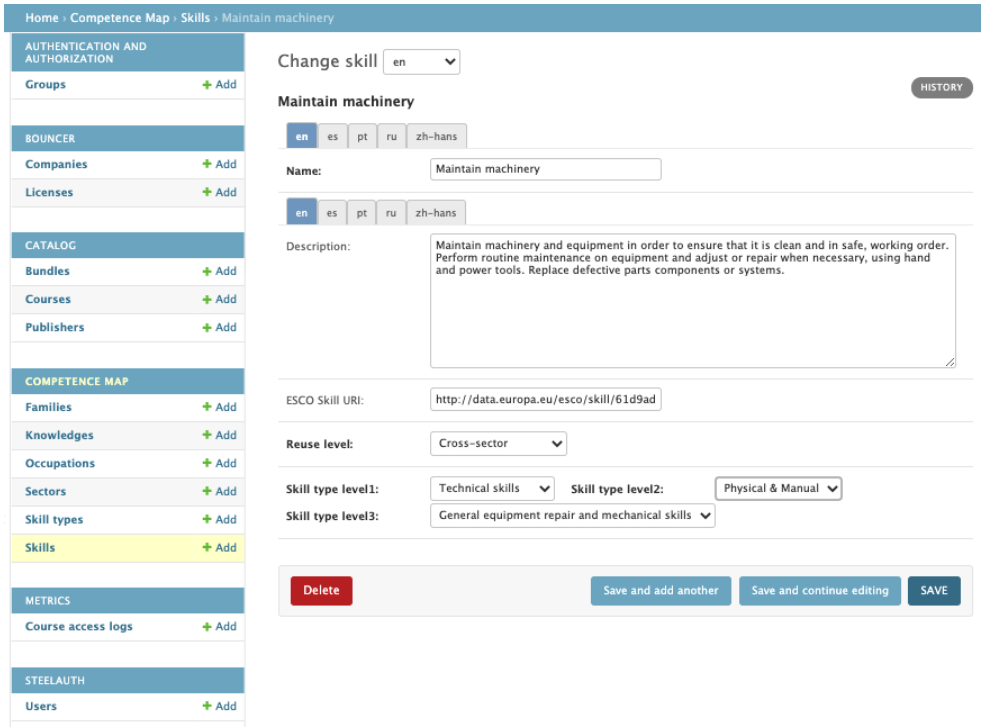
Knowledges + Add
Occupations + Add
Sectors + Add
Skill types + Add
Skills + Add
METRICS
Course access logs + Add
STEELAUTH
Users + Add
Change sector en
HISTORY
Steel
en es pt ru zh-hans
Name: Steel
en es pt ru zh-hans
Description:
FAMILIES
NAME DETAILS
Blast Furnaces Details
Coke Batteries Details
Heavy Plate Mill Details
Hot Rolling Mill Details
Melting Shop Details
Raw Materials and Sinter Details
Steel works Details
Delete
Save and add another
Save and continue editing
SAVE

(b)



(c)



(d)

Figure 22: steelHub online database including the data from ESSA Steel Professional Role Profiles Description: (a) steel job profiles, their job families and related ESCO occupations (b) information related to the selected steel job profile (such as description, ISCO number, functions etc.) (c) and (d) ESSA skill categories.

The front end of steelHub has been developed in order to show the Data Base in different format, depending on the user interest. The following figure (Figure 23) shows the first design of the Occupation of Maintenance and repair engineer (2141.7).

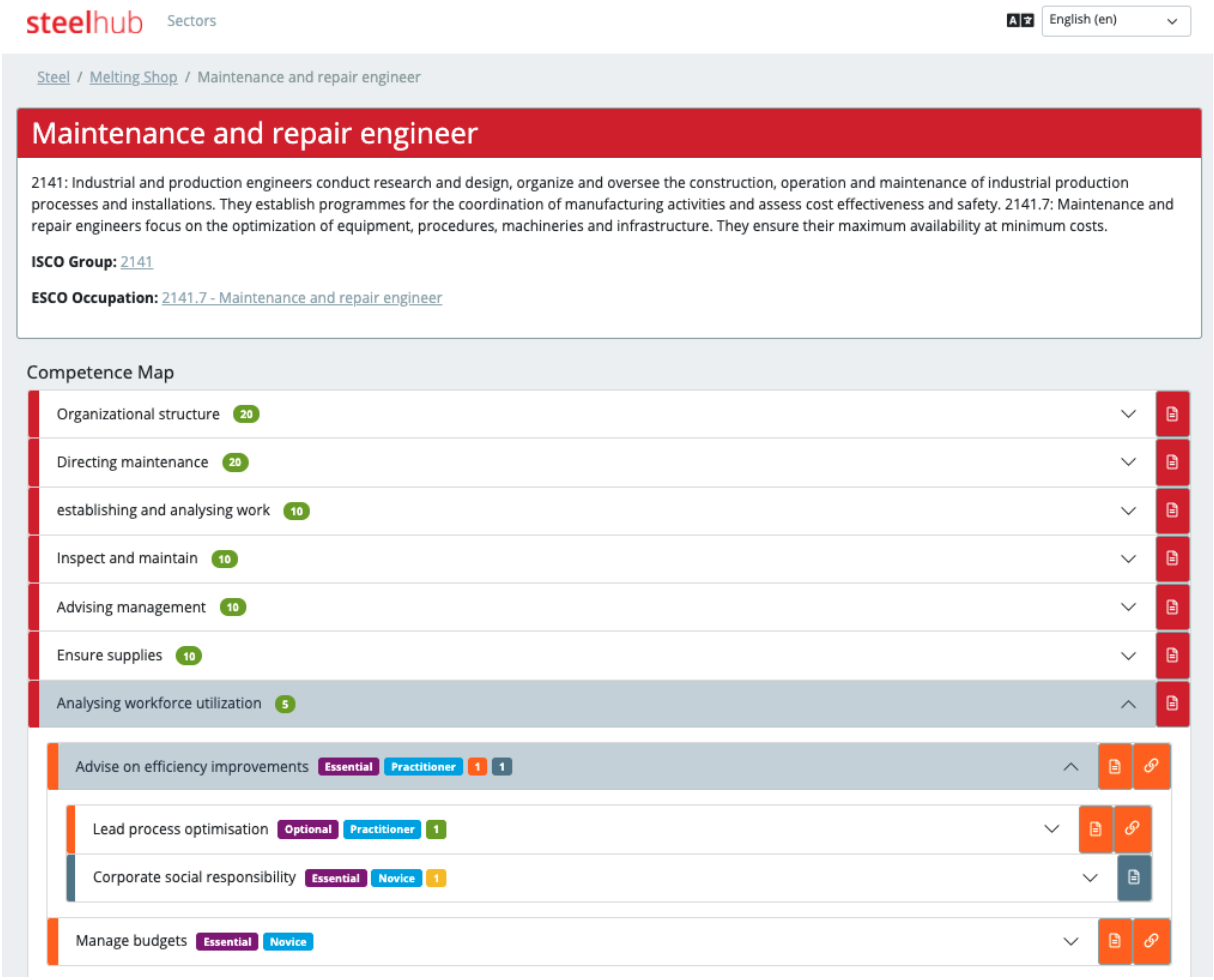


Figure 23: steelHub front-end page

The further development and running of the steelHub will be coordinated by Worldsteel, done collaboratively with divided responsibilities due to the expertise and preferences of the involved companies and training providers. [34]

4.6 Talent Management and Recruitment

Use in assessment and career

Increasingly rapid advances in technology and the labour market require graduates and professionals in the workforce to be familiar with state-of-the-art knowledge, and to possess the skills and competences needed to make full use of technological and non-technological know-how. Content-laden degrees are not always effective for adult learners in today's fast paced environment and employees also need 'just-in-time' skills development that is immediately applicable. This trend is likely to accelerate with the economic crisis triggered by the COVID-19 pandemic. [7] Therefore, the demand for short learning options and their *recognition* and *validation* is likely to further increase as a means to a sustainable recovery from the COVID-19 crisis.

In order to tackle this situation, a European approach to micro-credentials is on development with the objective to facilitate validation, recognition and portability, and to foster a larger uptake to support individual learners to gain and update their knowledge,

skills and competences in any subject area, at all stages of their career and in any learning environment. [35] A micro-credential is a qualification evidencing learning outcomes acquired through a short, transparently-assessed course or module. Micro-credentials are offered by higher and vocational education and training (VET) institutions, as well as by private organizations [35].

The Micro-Credential is based on validation of Learning Outcomes, which is aligned with the Learning Outcome Pipeline described in previous section as part of WP3. Therefore, the training content uploaded into steelHub is curated with learning outcomes to connect them with a particular occupation. The learning outcomes acquired and validated during the training process represent the evidence of the competence of the student for a particular occupation. This information can be recorded into steelHub and reported to Europe Tools, like EuroPass, to facilitate portability.

In other words, the European Steel Sector Professional Role Profiles may be used to implement an effective competence assessment process for Steel Sector people. Defining and implementing an internal competence assessment process enables verification of an organisation's existing roles and aids identification of competence gaps.

The result of the assessment can be used to improve accuracy of different processes:

- In training, the competence gap analysis can be used to design accurate training paths that can, for example, develop the proficiency levels required to meet organisation requirements.

- In the development of an organization the result of the assessment can be used to guide the design of the organization itself, allocating resources optimally and identifying the competence shortcomings to inform the recruitment process.

- In career development, recruitment and talent management, the outcome of individual assessments can be used to identify optimal career development paths of the STEEL SECTOR professional, benefiting the employee and the organisation

To make an assessment process accurate and effective a working tool can be developed integrating the skills and the organisation Job Profiles; they can be derived starting from the Role Profiles described in this work package.

Use in Curriculum design

In the context of qualification development and VET system curricula design, the European STEEL SECTOR Professional Role Profiles can be used as

- A communication tool between employers and educators which improves consultation process and outcomes

- A starting point for more detailed Role Profiles and curricula design in specialised fields (e.g. STEEL SECTOR Security, Data and Big Data)

- Within VET system curricula (However, we need to acknowledge that VET systems are often difficult to influence, especially at the IVET level (CVET seems to be a more approachable target). More can be done in market-based VET provision like in the UK, where awarding bodies have more autonomy, less can be done in state-based systems like Italy and Poland.)

The European STEEL SECTOR Professional Role Profiles is also generated to be used in the process of curricula design. One of the key challenges of effective curricula design is

managing how different stakeholders communicate and cooperate to design curricula that meet both educational and employer objectives. The STEEL SECTOR Profiles and the skills shift, can provide a useful shared language and starting point so that discussions between these stakeholders are quickly focused on useful content rather than constantly re-explaining the foundations of the debate. Different stakeholders have different perspectives, terminologies and ways of thinking about Steel Sector knowledge, skills and competence. The Steel Sector Profiles in line as much as possible with the ESCO terminology and description can be used to provide a bridge or communication tool to facilitate this process.

Professional Role Profiles add a crucial step by providing informative examples of which skills are needed for which tasks. This means that the employer can easily start with the tasks that need to be done and work back to what skills can be included in the curricula by educators. This will significantly speed up the agreement on curricula design between employers and educators.

This means that in terms of updating curricula for new or changed activities in the workplace a structure is in place to inform that debate. For example, when analysing the educational needs of a specific job, an aligned European STEEL SECTOR Professional Role Profile may be adopted to form a common vision of the role and its associated educational requirements. The competences within a profile provide guidance on skills and knowledge items that can be developed to inform VET system curricula design and desired learning outcomes

4.7 Train the trainers

Regarding the 'train the trainers' approach, we have been considering active learning methodologies which have been proven as more efficient than the traditional methods. These methodologies which provides learning based on tasks, problems, projects, challenges, case studies, etc. have the aim to engage and motivate the involved learners and they are referred as learner - centered methodologies. Their goals are the construction of meaningful learning, the provision of an active process of knowledge construction, keeping the learners' attention, emphasizing their independence and inquiry, and, in the last term, improving the pass rates. Problem Based Learning (PBL) and Project-based learning (PjBL) are methods widely used in the world of education. Their objective is to enhance "self-directed learning" skills, by changing the usual lecturer role of teachers towards a mentoring role. Thus, PjBL has a wider and a more complex scope and often includes the design and creation of a product, and requires a multi-disciplinary and multi-subject approach, while PBL is more specific and it is often based on a single-subject. PjBL may use scenarios, but often involve real world, fully authentic tasks and settings, while PBL often uses fictitious scenarios as "illustrated problems" or real-life situations that correspond to real case studies. Real Case Solving (RCS) is a variant of the PBL where learners solve real cases and actual problems of the companies through the application of the PBL methodology.

During the 'train the trainers' process, for each different case, the most appropriate of these active learning methodologies can be easily adapted.

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ANNEX I

ESSA Skill Categories

The detailed description of the level 1, level 2 and level 3 skills categories are below.

Level 1 Skills Categories:

Technical skills: Technical skills are a set of abilities required to use physical tools, equipment, operations and functions in order to achieve particular outcomes. They include the ability to use new machines and information and communication technology devices, the ability to use and manipulate materials and tools, the ability to mobilise one's capacities, including strength, muscular flexibility and stamina [1].

Transversal skills: Transversal skills typically have high transferability across different jobs and sectors [2]. They are relevant to a broad range of occupations and economic sectors and often referred to as core skills, basic skills or soft skills, the cornerstone for the personal development of a person [3].

Level 2 Skills Categories

Physical and manual skills: Physical skills are a set of abilities to use physical tools, operations and functions. They include manual skills, such as the ability to use information and communication technology devices and new machines, play musical instruments, craft artworks, play sports; life skills, such as the ability to dress oneself, prepare food and drink, keep oneself clean; and the ability to mobilise one's capacities, including strength, muscular flexibility and stamina [1]. Practical physical skills are those required to use and manipulate materials, tools, equipment and artefacts to achieve particular outcomes [1].

Digital skills: Digital skills are broadly defined as the skills needed to use digital devices, communication applications, and networks to access and manage information [4]. Several terms, such as 'digital literacy', 'digital competence', 'ICT-related skills' and 'e-skills' are often used synonymously to describe digital skills. In general, digital skills encompass a range of basic to highly advanced skills that enable the use of digital technologies (digital knowledge) on the one hand, and basic cognitive, emotional or social skills necessary for the use of digital technologies, on the other hand. Digital competence includes not just digital skills, but a set of skills, knowledge and attitudes concerning the nature and role of information technologies and the opportunities they offer in everyday contexts, as well as the related legal and ethical principles. It also includes critical and reflective attitudes towards the information available and its responsible use [5,6].

Green skills: Green skills are those skills needed to adapt products, services and processes to climate change and the related environmental requirements and regulations (such as low carbon emission regulation) [7]. They can be referred as the knowledge, abilities, values and attitudes needed to live in, develop and support a sustainable and resource-efficient society [8].Green skills will be needed by all sectors and at all levels in the workforce [7].

Social skills: Social skills are a set of individual capacities that can be manifested in consistent patterns of behaviours that enable people to cultivate their relationships at home, school, work and in the community, and exercise their civic responsibilities [9].

We use social skills to facilitate interaction and communication with others both verbally and non-verbally, through gestures, body language and our personal appearance. Social rules and relations are created and changed through social skills [10].

Methodological skills: We can also use 'cognitive skills' definition for these skills. They are the type of skills used in the process of obtaining and understanding new knowledge through

thought, reflection, experience, and the senses [11].

Individual-Personal skills: Personal skills refer to the inner abilities or skills of an individual and they are recognized as soft skills which are not easy to teach (although not impossible)[a**13**]. They are the skills possessed by a person which are deemed to be their strengths or weaknesses.

Level 3 Skills Categories

General equipment operation: Skills needed to handle and operate heavy or medium equipment such as knowledge of production procedures, physical stamina and strength, ability to read blueprints, schematics and manuals etc.

General equipment repair and mechanical skills: They are the skills required to repair and maintain the function and/or cleanliness of equipment and machinery. Some of the skills involved in this category are equipment maintenance, preventive maintenance, repairing, troubleshooting, installation, reading comprehension (for manuals and blueprints), suitable equipment selection, operation monitoring etc.

Craft and technician skills: (Craft and technician skills are the ones required to use and manipulate materials, tools, equipment within a craft to achieve particular outcomes [1].

Craft skill is defined as understanding and assimilation of the total technology of a craft and its application in any craft situation so as to produce effective and satisfying results [12]. Therefore, the term "craft skills" is related to specific pieces of practical knowledge within a craft.

Some of the essential features of craft skill are: -Knowledge of techniques of working, jointing, fixing and finishing materials, both traditional and modern. -Skill in the use of tools and appliances in working, jointing, fixing and finishing (manual skills) -mathematical skills involved in the preceding features. - Integrity, resourcefulness and determination, coupled with the ability to respond intelligently to constantly changing circumstances in the work as it proceeds [12].

Gross motor skills and strength: This category of skills refer to the ability to mobilise one's capacities, including physical strength, muscular flexibility and stamina.

In particular, gross motor skills are abilities that allow people to do things that involve using the large muscles in the torso, arms and legs to complete whole-body movements [13].

Inspecting and monitoring skills: These skills are needed to observe and record the production or management activities regularly through gathering information on all aspects in order to check everything is correct or legal.

Basic digital skills: The basic digital skills needed in a day-to-day professional or personal context can be outlined in six areas [14] **:**

1) Digital foundation skills – the fundamentals of being able to use digital technologies, such as using a browser, connecting to the internet, and keeping passwords secure.
2) Communicating – sending emails securely, using attachments, and participating on social media. (Communicating, collaborating, and sharing)
3) Handling information and content – using search engines, being aware that not all online content is reliable, accessing content across devices. (Finding, managing and storing digital information and content securely)
4) Transacting – setting up accounts to use or purchase goods/services online, using different secure payment methods, filling in online forms. (Register and apply for services, buy and sell goods and services, and administer and manage transactions online)

5) Problem-solving – finding solutions to problems FAQs/tutorials/chat, presenting solutions through software, and improving productivity. (Find solutions to problems using digital tools and online services)
6) Being safe and legal online – understanding best practice in data storage/sharing, updating and keeping passwords secure, and taking precautions against viruses. (Staying safe, legal and confident online)

Advanced data analysis and mathematical skills: The ability to apply statistical and/or logical techniques systematically in order to describe and illustrate, condense and recap, and evaluate data [15] Some examples for the skills in this category are advanced excel skills (PivotTable, VBA program development), Structured Query Language (SQL) queries, data visualization, statistical programming languages (such as Pyton or R), AI and Machine Learning [16].

Cybersecurity: Cybersecurity is to protect and defend IT systems, network, digital information, and every asset that form part of an IT infrastructure in an organization [17]. Some of the skills needed for cybersecurity are IT fundamentals (like system and web application administration), understanding architecture, administration, and operating systems, database knowledge (essential for cybersecurity IT job roles), Coding skills—C, C++, Java, Python, Ruby, Perl, PHP (essential for an application security engineer, security analyst, ethical hacker, penetration tester, etc), communication, analytical thinking, collaboration, literacy [17].

Use of complex digital communication tools: The ability to manage any piece of software or platform facilitating internal and external communication. Complex digital communication tools are content review and proofing software, project management software, instant messaging software, social intranet & internal communication software, video conferencing software, workflow software, survey software, marketing reporting software etc. [18]

Advanced IT skills & Programming: This category of skills refer to the ability to use Internet and email, computers, word processing, graphics, analytics, multimedia, spreadsheets and databases and ability to program/code [19].

Environmental awareness: Being environmentally aware means understanding how our behaviour impacts the environment and committing to making changes to our activities to protect the environment [20]. These generic 'green' skills include the capacity to include environmental concerns alongside others (such performance and safety) in taking decisions, including in the choice of processes and technologies [21].

Energy efficiency: This term refers to the ability to perform a more efficient, conservative use of energy in the production plant [22], which includes the ability to understand energy use, to perform project planning and management -in attaining goals of energy efficiency assessment - , to identify potential opportunities related to efficient energy use, and to install appropriate monitoring equipment and develop analysis systems, to develop and assess business cases for implementation of energy efficiency opportunities [23].

Water conservation: It refers to the ability to perform a more efficient, conservative use of water in the production plant which includes the ability to monitor sites, to negotiate with regulatory authorities, or professionals such as engineers, planners and surveyors, to advise about possible water conservation solutions and to keep up to date with changes in legislation/EU directives [24].

Waste reduction and waste management: Waste reduction (source reduction) is the ability to use less material and energy to minimize waste generation and preserve natural resources. It is broader in scope than recycling and incorporates ways to prevent materials from ending up as waste before they reach the recycling stage [25]. Waste management herein refers to the skills required to collect, transport, dispose or recycle and monitor waste [26].

Resource reuse/recycling: The ability to reprocess of discarded waste materials for reuse, which involves collection, sorting, processing, and conversion into raw materials which can be used in the production of new products [27]. It involves the ability to maintain inventory of recyclable materials, to plan, coordinate and manage the separation of recyclable materials for compaction, storage and shipment, to recover recyclable materials, to inspect and dispose of unrecyclable materials etc. [28]

Advanced communication and negotiation skills: Advanced communication skills refer to the ability to access to ways to guide and direct communication between yourself and another or a groups that you can achieve your goals and outcomes [29]. This ability requires a good understanding of how the communication process works: using and reading body language and nonverbal cues (eye contact, facial expressions, hand, arm gestures, posture etc), as well as using verbal communication effectively and listening actively. Some other skills that contribute to this ability are confidence, teamwork skills, persuasion skills, presentation skills, enthusiasm, patience, improvisation and empathy [30].

Negotiation skills is the ability that allow two or more parties to reach a compromise or an agreement avoiding any kind of argument and dispute [32,33]. These are often soft skills and include abilities such as communication, persuasion, planning, strategizing and cooperating. Understanding these skills is the first step to becoming a stronger negotiator [31].

Interpersonal skills and empathy: Interpersonal skills are the behaviors and tactics a person uses to interact with others effectively. Interpersonal skills are often referred to as social intelligence. We use these skills every day when we communicate and interact with other people, both individually and in groups [32,33]. Therefore interpersonal skills include a wide range of skills such as emotional skills (the ability to control and manage your emotions), negotiation and persuasion skills, communication skills (active listening, effective speaking etc), collaboration, conflict resolution [34,35].

Empathy is a key element in interpersonal relationships**:** Empathy is the ability to recognize emotions in others, and to understand other people's perspectives on a situation [36]. It requires active listening, full attention and understanding attitude. At its most developed, empathy enables you to use that insight to improve someone else's mood and to support them through challenging situations [36].

Leadership and managing others: Leadership skills are the abilities an individual use when guiding initiatives and organizing other people toward the achievement of a shared goal [37,38].Whether you're in a management position or leading a project, you use leadership skills to manage others; you encourage them to complete a series of tasks according to a schedule through motivation and feedback and also hold them accountable. Some of the skills that make a strong leader include: strategic thinking skills, organizing skills, risk management, communication, decision-making, problem-solving, creativity, patience, empathy, flexibility, reliability [39].

Entrepreneurship and initiative taking: Sense of initiative and entrepreneurship refers to an individual's ability to turn ideas into action. It includes creativity, innovation and risk-taking, as well as the ability to plan and manage projects in order to achieve objectives [40]. This supports individuals in the workplace in being aware of the context of their work and being able to seize opportunities, and is a foundation for more specific skills and knowledge needed by those establishing or contributing to social or commercial activity. This should include awareness of ethical values and promote good governance.

Adaptability and continuous learning: Adaptability is referred as the quality of being able to change or be changed in order to deal successfully with new situations [34]. In industrial context, adaptability means one is able to quickly respond to changing trends, innovation, destabilization, industry shifts, and so forth. This ability to adjust or shift makes an employee nimble [41].

Only people who are curious and embrace learning can be adaptable. Therefore, continuous

learning gains a lot of importance.

Continuous learning is the process of expanding skills and skills-sets on an on-going basis through increasing knowledge. On a professional level, continuous learning is about further learning new skills in response to a changing environment and new developments [42]. This can come in many forms, from formal course taking to casual social learning. It involves self-initiative and taking on challenges. Continuous learning can also be within an organization, or it can be personal, such as in lifelong learning [43].

Teaching and training others: Through teaching and training, one can help to develop other person's subject knowledge and maybe even their mind and personality [44].Some general qualities in order to teach and train others are: to have confidence, patience, self-discipline, time management, high communication and organizational skills, ability to work effectively in groups, motivate others, empathize with others, and deal with conflict etc.

Critical thinking & decision making: Critical thinking refers to the ability to analyze information objectively and make a reasoned judgment/logical decision. It involves the evaluation of sources, such as data, facts, observable phenomena, and research findings [45]. "What is Critical Thinking]. Good critical thinkers can draw reasonable conclusions from a set of information, and discriminate between useful and less useful details to solve problems or make decisions [46]. An employee with critical thinking skills can be trusted to make decisions independently, and will not need constant handholding.

Personal experience: The level of experience gained by an employee throughout her/his career by carrying out the same or similar tasks to those required by their current position.

Adapt to change: being able to adapt to changes and developments.

Work autonomously: The more expertise you have, the greater responsibility you have in making these decisions independently. With greater autonomy comes less support or supervision but increased accountability [47].

Working autonomously requires ability to achieve results with no supervision or with limited supervision, ability to work both independently and as a member of a team, to make independent decisions and solve problems on your own. It also demands self-motivation, confidence and time management,

Active listening: Active listening is the ability to concentrate completely on a speaker, understand their message, comprehend the information and respond thoughtfully. It involves listening with all senses. Unlike passive listening, which is the act of hearing a speaker without retaining their message, this interpersonal communication skill ensures you're able to engage and later recall specific details without needing information repeated. Active listeners use verbal and non-verbal techniques to show and keep their attention on the speaker. This not only supports your ability to focus, but also helps ensure the speaker can see that you are focused and engaged [48.49].

Basic numeracy and communication: If one has basic numeracy skills, it means that he/she is able to manage simple arithmetic (even if using a calculator) and has a good understanding of some basic mathematical concepts such as percentages, fractions, measurements, decimals etc. [50].

Communication skills are the skills needed to express ideas and views clearly, confidently and concisely in speech, writing and body language [51]. Communication skills involve listening, speaking, writing, observing and empathizing [52].

Basic data input and processing: the ability to enter the collected data into an input device in order to convert it into a machine-readable form and to get the input data transformed into a more meaningful form (information) in the CPU (central processing unit).

Advanced literacy: Literacy skills demonstrates the skills for reading and writing. If you have basic literacy skills, you must be able to understand and comprehend things that you read and similarly must be able to make yourself understood by others using the written

word [50]. On the other hand, advanced literacies refers to the skills and competencies that enable communication, spoken and written, in increasingly diverse ways and with increasingly diverse audiences. Advanced literacies also promote the understanding and use of text for a variety of purposes. Likewise they make way for participation in academic, civic, and professional communities, where knowledge is shared and generated [53].

Quantitative and statistical skills: Quantitative information is objective and comprised of numerical, measurable data [54]. Quantitative skills involve the ability to handle data and use numerical evidence systematically. It is the ability to reason using numbers [55]. With quantitative data analysis skills, a person will be able to understand and interpret data and findings related to budgeting, mathematics, statistical analysis, probability, software applications, operations management and other areas of business strategy and management [54]. Additional quantitative skills would include: Mathematical Skills, Analytical Skills, Survey Skills, Science Skills, and Research Skills [56].

In particular, statistical skills refers to the collection, organisation, analysis, and interpretation of numerical data. Some of the statistical skills are: Basic algebra and mathematics, Data distributions, Data analytics, Statistics and probability, Data visualization: Excel, Google Charts, Tableau etc. [57]

Complex information processing and interpretation: It can be referred as the ability to get complex raw data transformed into a meaningful form (information) in the CPU (central processing unit) and evaluate the output [58].

Process analysis: Process analysis as a skill refers to the ability to carry out a systematic review of all steps and procedures followed to perform a given activity. It is a description of the way a particular task is done within an organization [59]. A process analysis can be used to improve understanding of how the process operates, and to determine potential targets for process improvement and increase efficiency [60].

Creativity: Creativity is the ability to think about a task or a problem in a new or different way, or the ability to use the imagination to generate new ideas. Creativity enables you to solve complex problems or find interesting ways to approach tasks. If you are creative, you look at things from a unique perspective [61].

Complex problem solving: Problem-solving skills refer to the ability to handle difficult or unexpected situations in the workplace as well as complex business challenges. Problem-solving skills help you determine the source of a problem and find an effective solution ***[1]***. Some other skills to contribute to this ability: Active listening, Analysis, Research, Creativity, Communication, Dependability, Decision making, Team-building. Effective problem solving may also require industry or job-specific technical skills.

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ESSA Skill Proficiency Levels

In the Professional Role Profile Template, 5 skill levels were adopted: Novice (0), Basic Actor (1), Practitioner (2), Expert (3), Master (4). Table 6 demonstrates and describes the five proficiency levels of ESSA and their description.

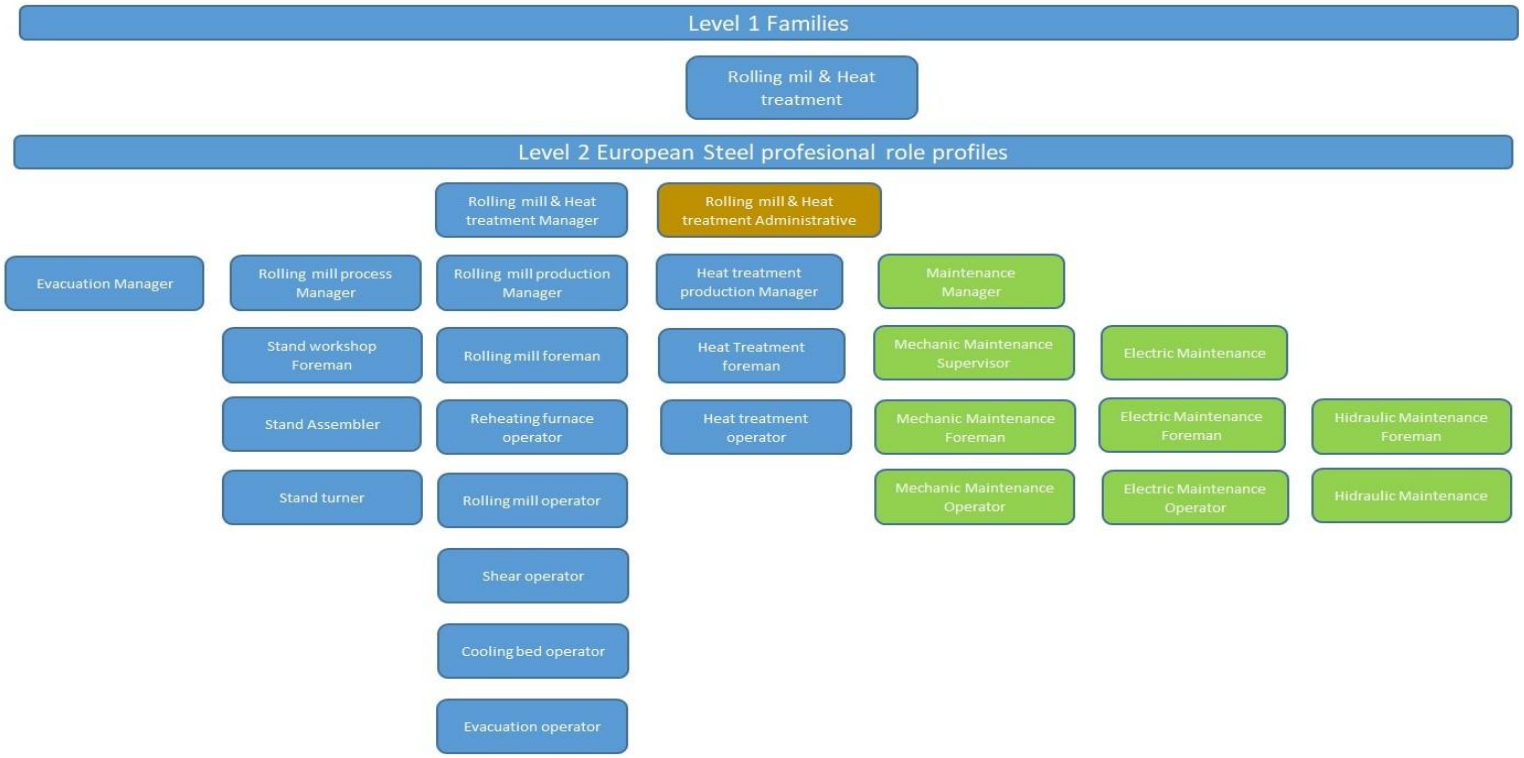
Table 6: Five ESSA proficiency levels for the skills assessment.

0	Novice	Does not have knowledge and skills
1	Basic Actor	Basic level of skills and knowledge, semi-skilled level, Rudimentary knowledge and some basic skills. Can't perform the activities independently.
2	Practitioner	Solid skills, knowledge and abilility, guidance needed to handle novel or more complex situations. Can perform the activities with enough knowledge and skills but requires some guidance and assistance in unexpected or not frequent situations and direct supervision
3	Expert	Advanced knowledge and ability, guides other professionals, applies skills in new or complex situations, develops new procedures or methods Can perform required activities with high level of knowledge and skills, without any guidance, assistance or direct supervision; can monitor, mentoring, advice others
4	Master	highly advanced skills, knowledge and abilities, proactively and personally capability building Can perform the activities showing the highest level of knowledge and skills, demonstrate initiative and adaptability to special problem situations and can lead and teach others in the activities

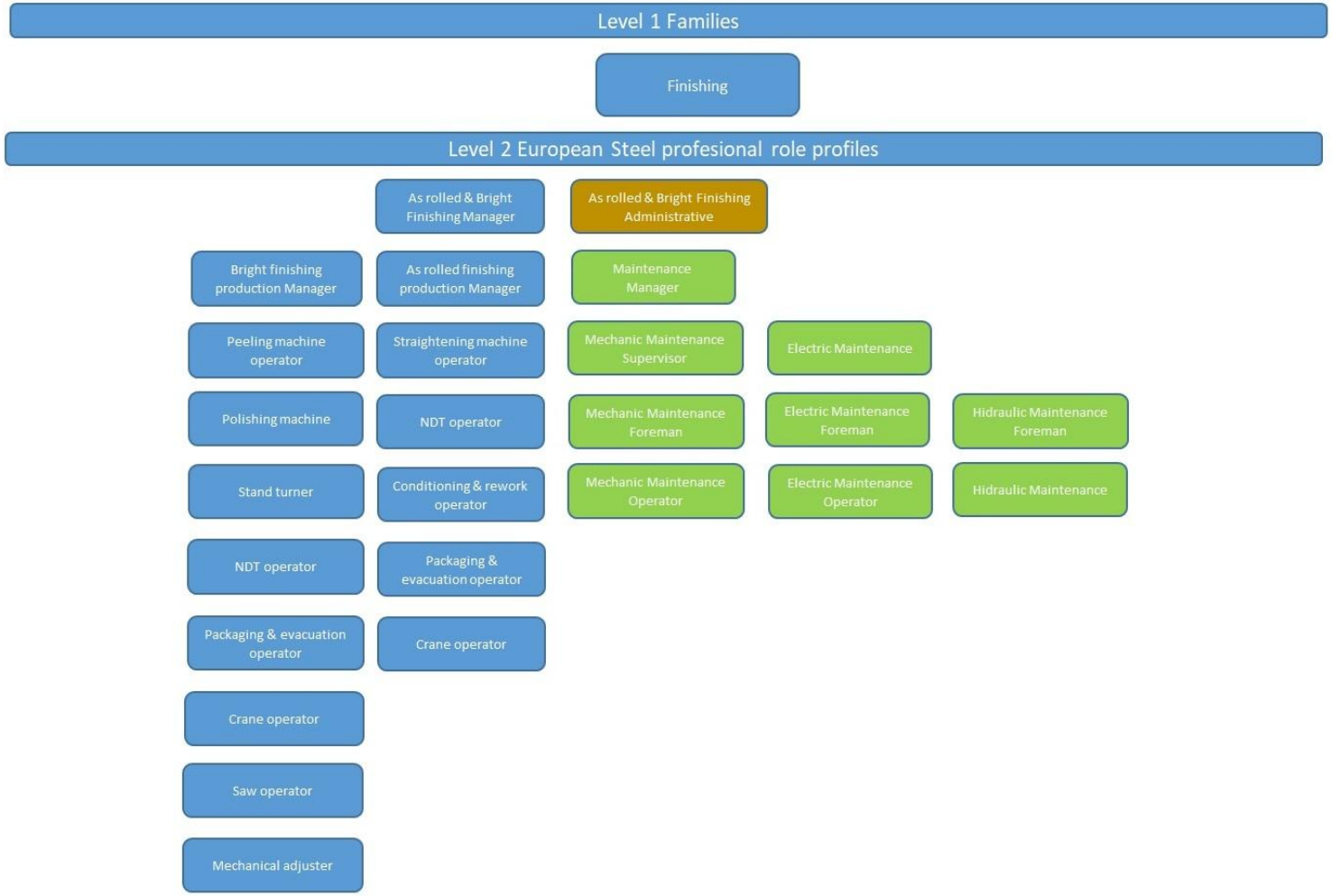
ANNEX II

European STEEL SECTOR Professional Role Profiles

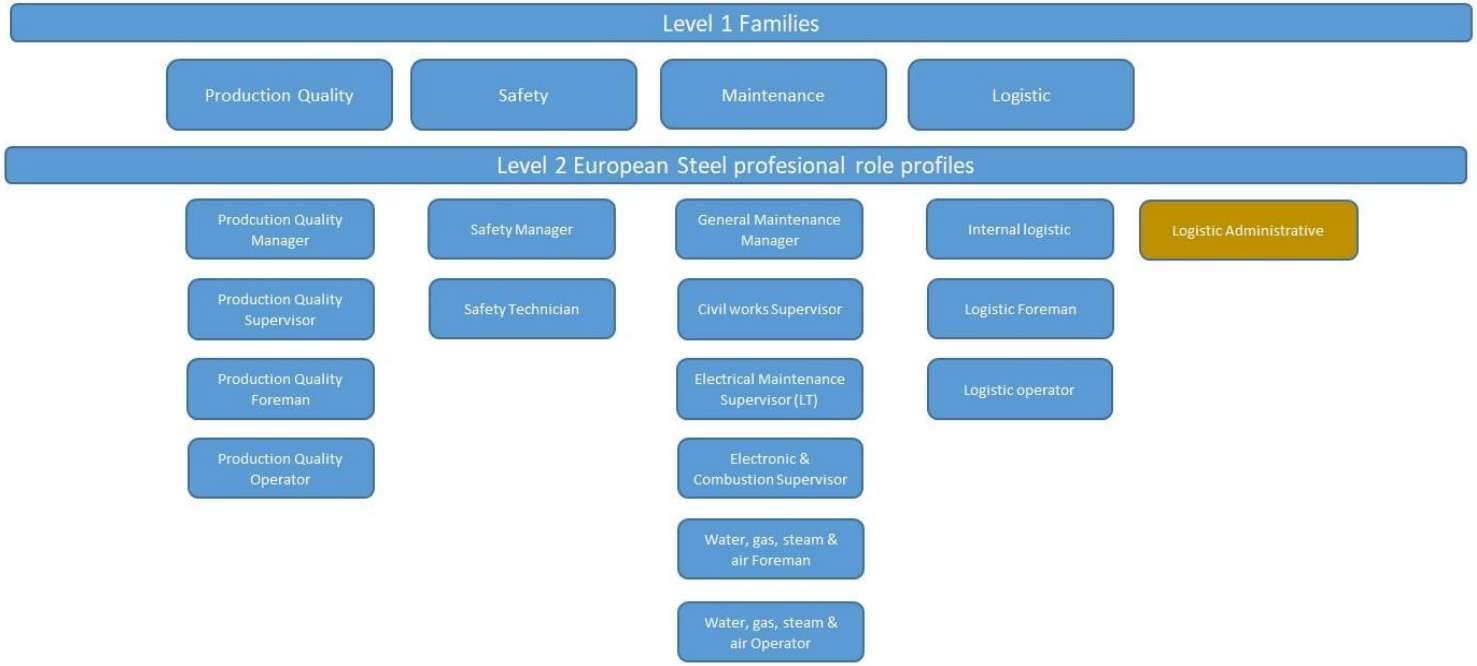
European STEEL SECTOR Professional Role Profiles: profiles (level 2) of Rolling Mill and Heat Treatment Family at the downstream of the European STEEL SECTOR Profile Family Tree



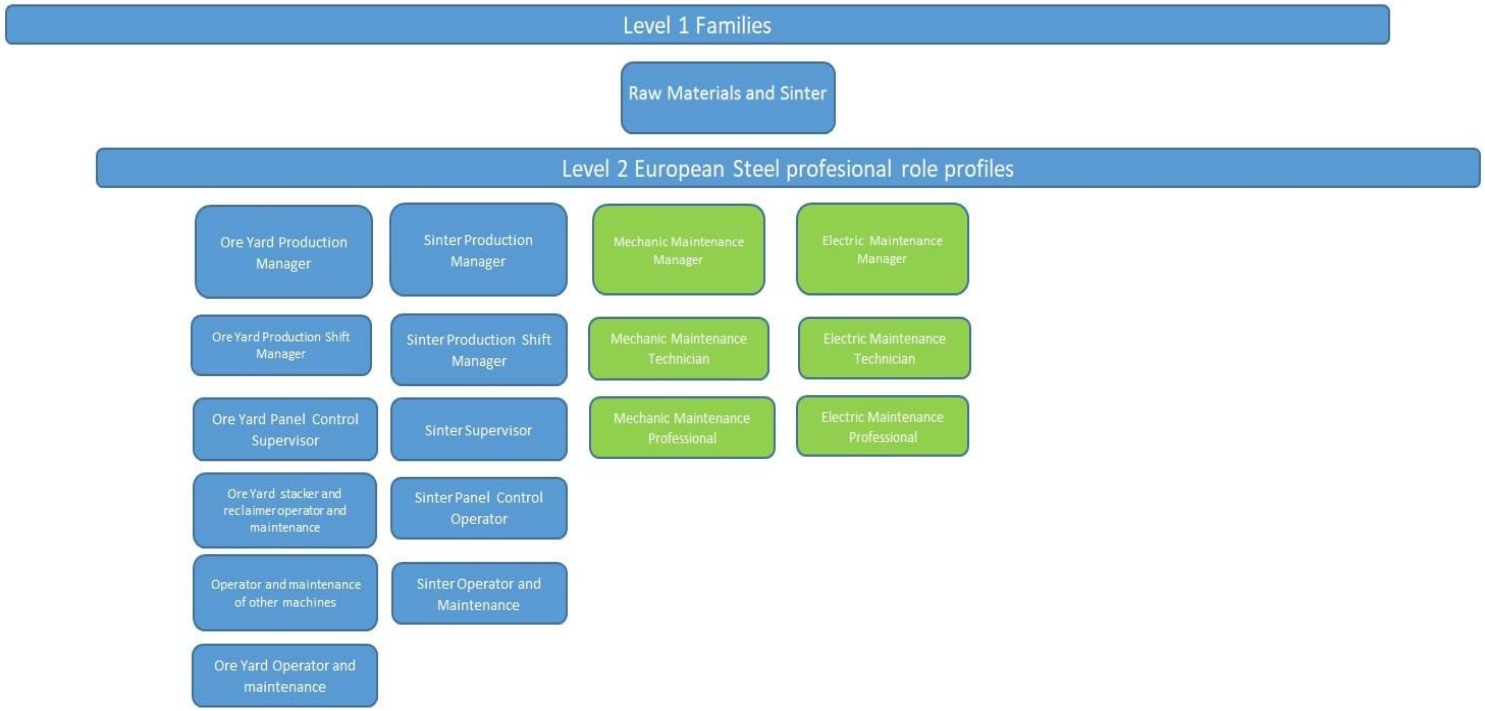
European STEEL SECTOR Professional Role Profiles: profiles (level 2) of Finishing Family at the downstream of the European STEEL SECTOR Profile Family Tree



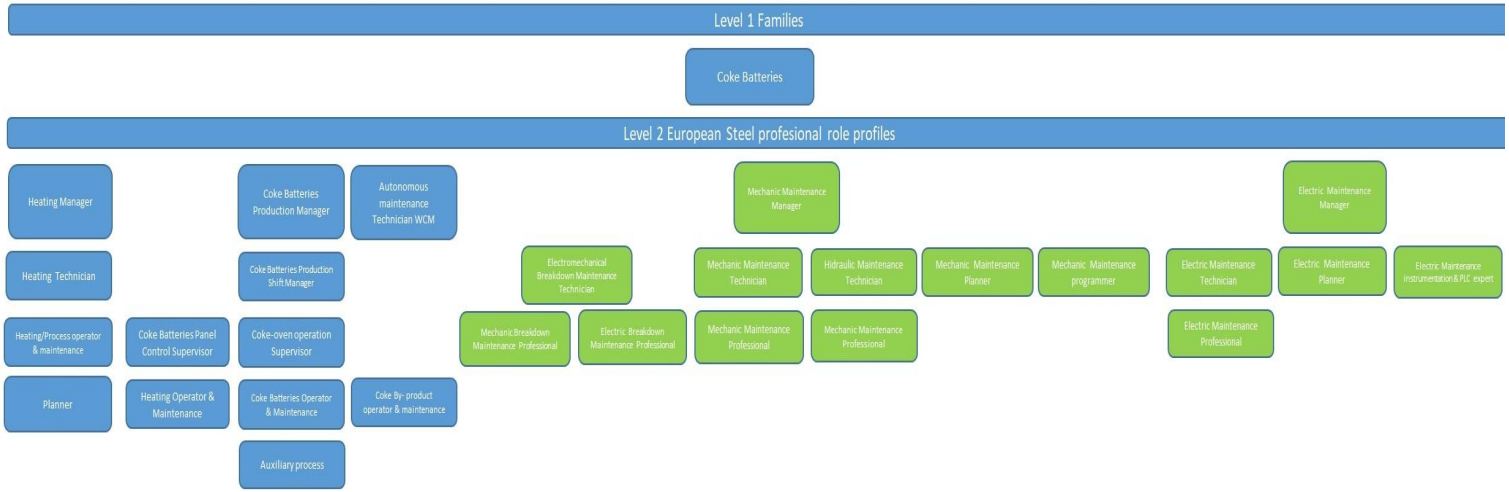
European STEEL SECTOR Professional Role Profiles: profiles (level 2) of Production Quality, Safety, Maintenance and Logistic Families at the downstream of the European STEEL SECTOR Profile Family Tree



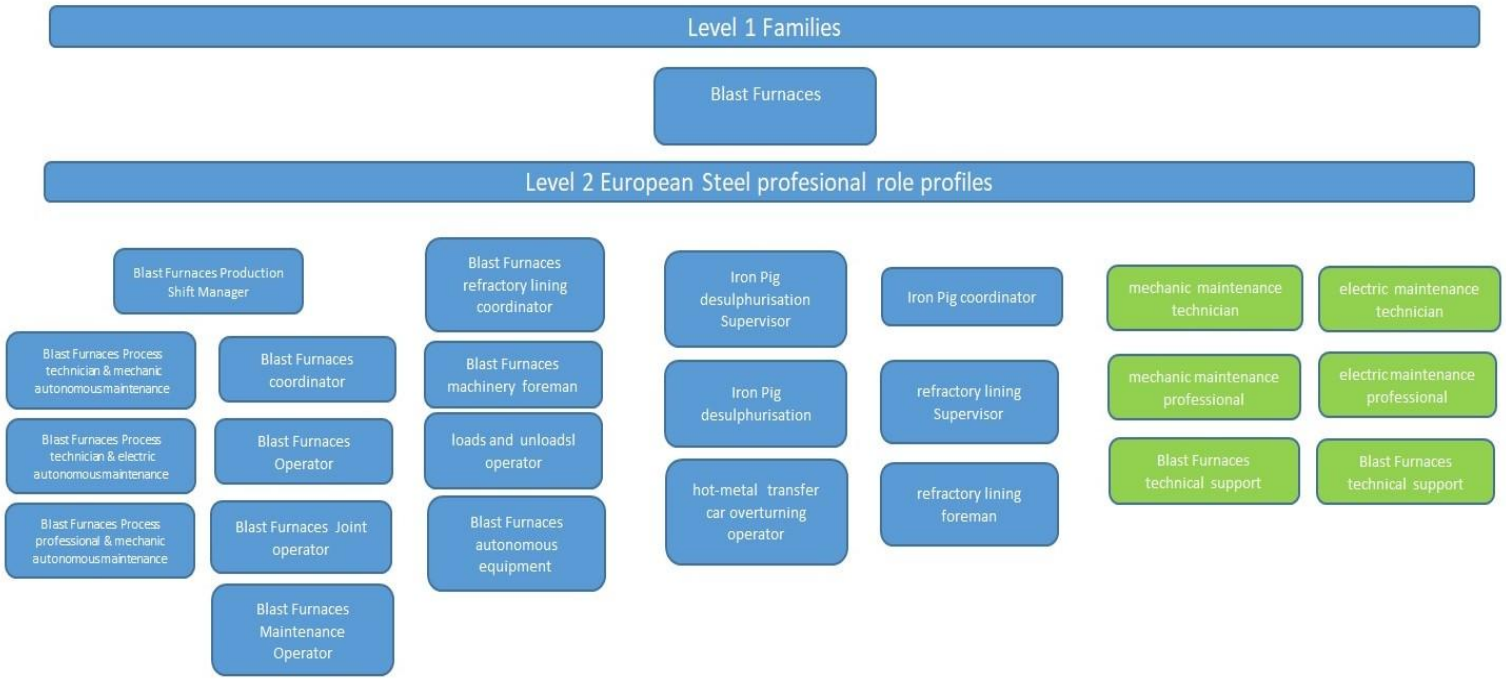
European STEEL SECTOR Professional Role Profiles: profiles (level 2) of Raw Materials and Sinter Family at the downstream of the European STEEL SECTOR Profile Family Tree



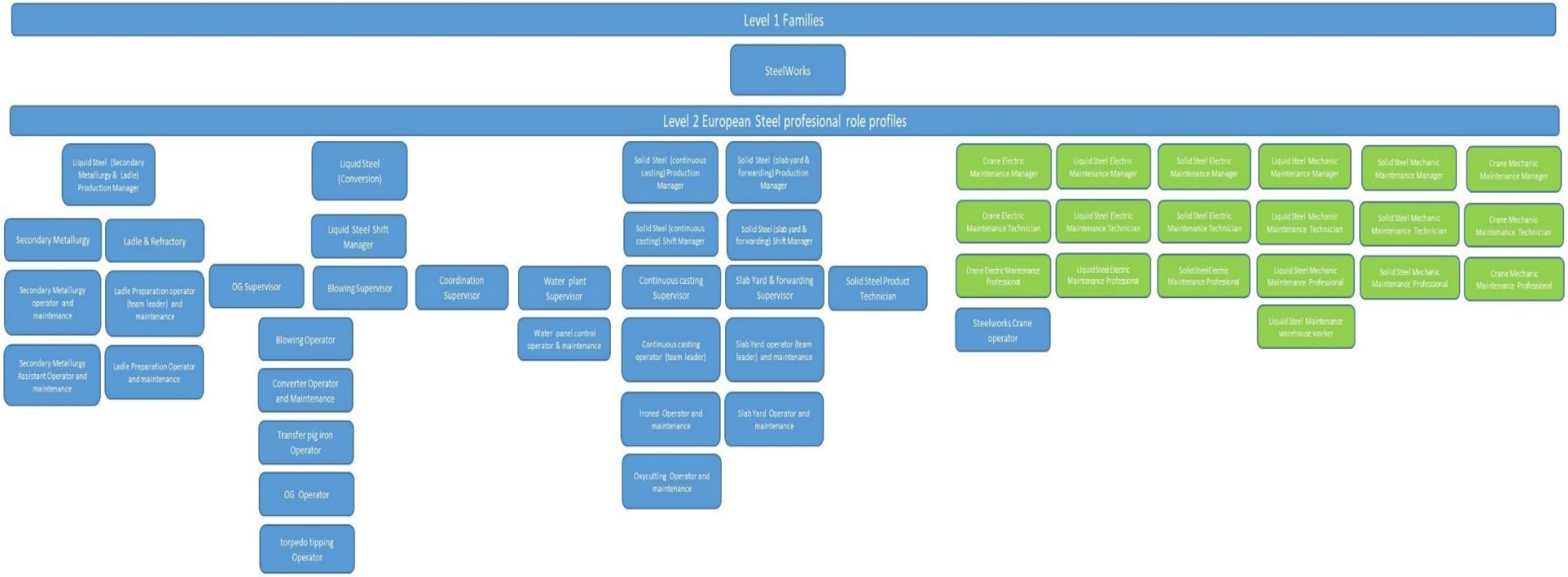
European STEEL SECTOR Professional Role Profiles: profiles (level 2) of Coke Batteries Family at the downstream of the European STEEL SECTOR Profile Family Tree



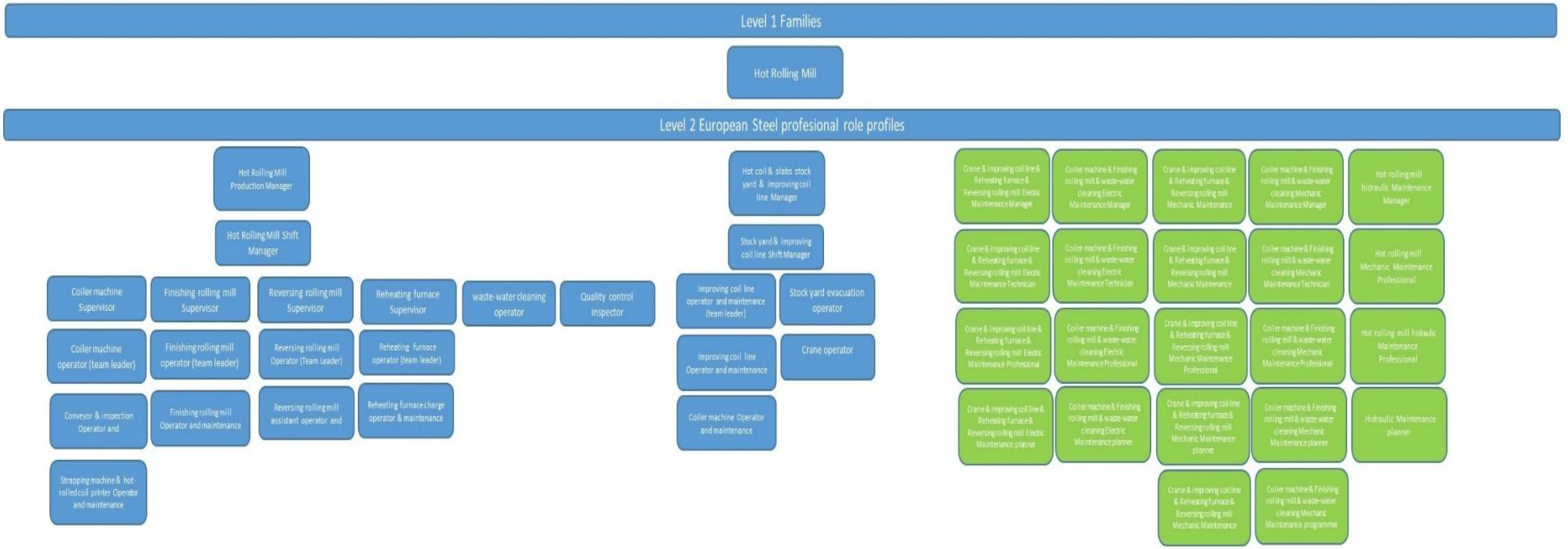
European STEEL SECTOR Professional Role Profiles: profiles (level 2) of Blast Furnaces Family at the downstream of the European STEEL SECTOR Profile Family Tree



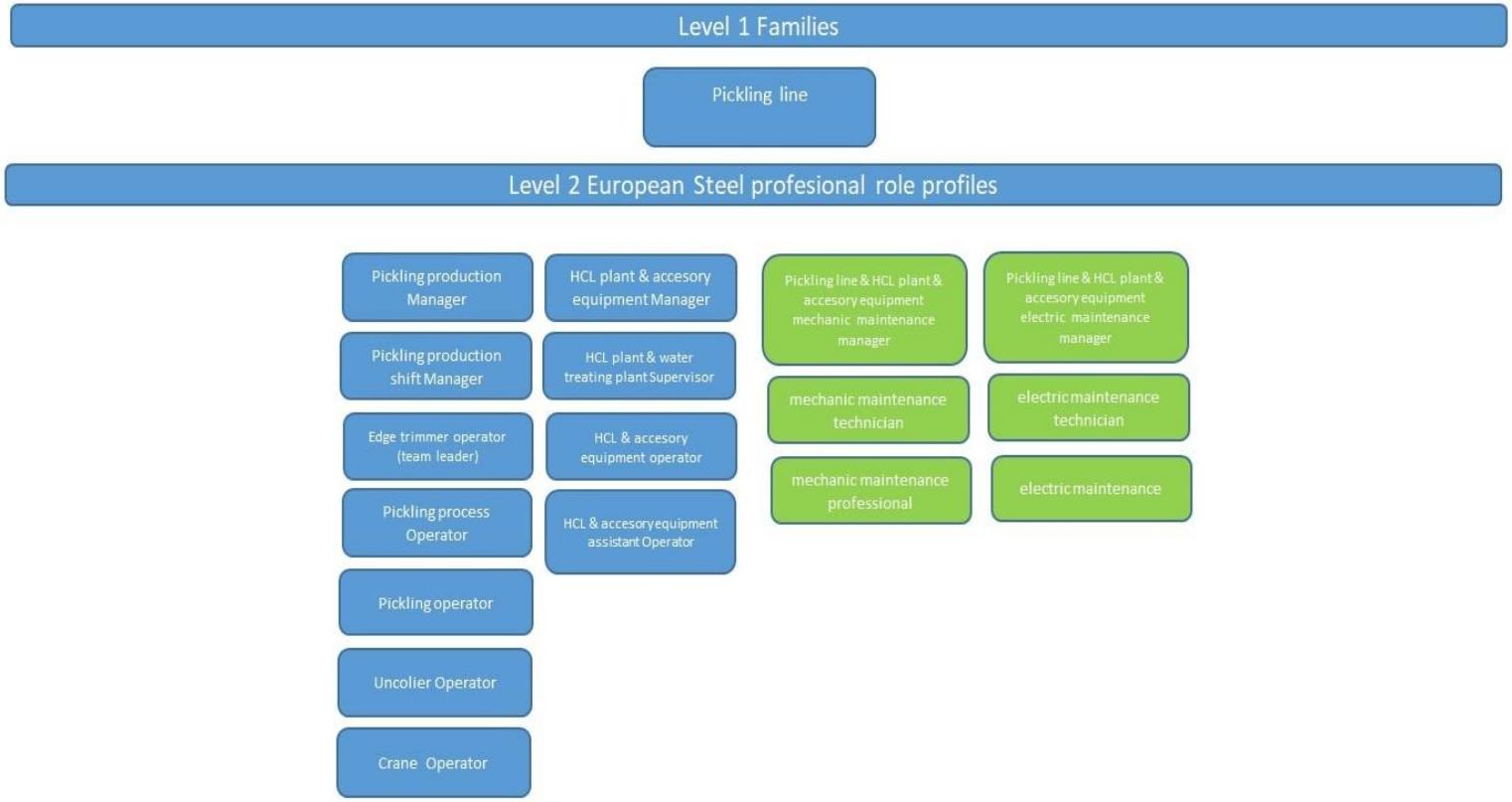
European STEEL SECTOR Professional Role Profiles: profiles (level 2) of Steelworks Family at the downstream of the European



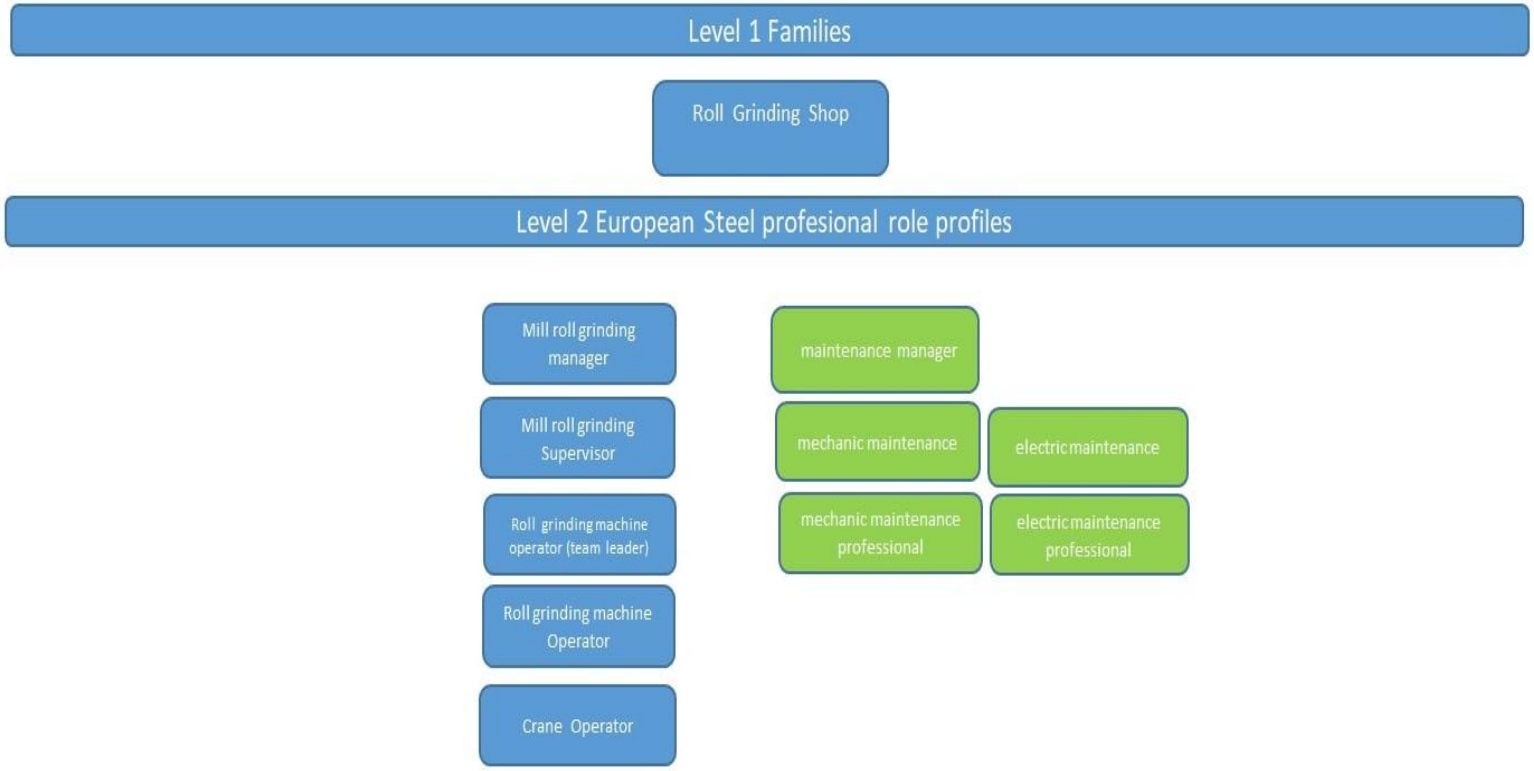
European STEEL SECTOR Professional Role Profiles: profiles (level 2) of Hot Rolling Mill Family at the downstream of the European STEEL SECTOR Profile Family Tree



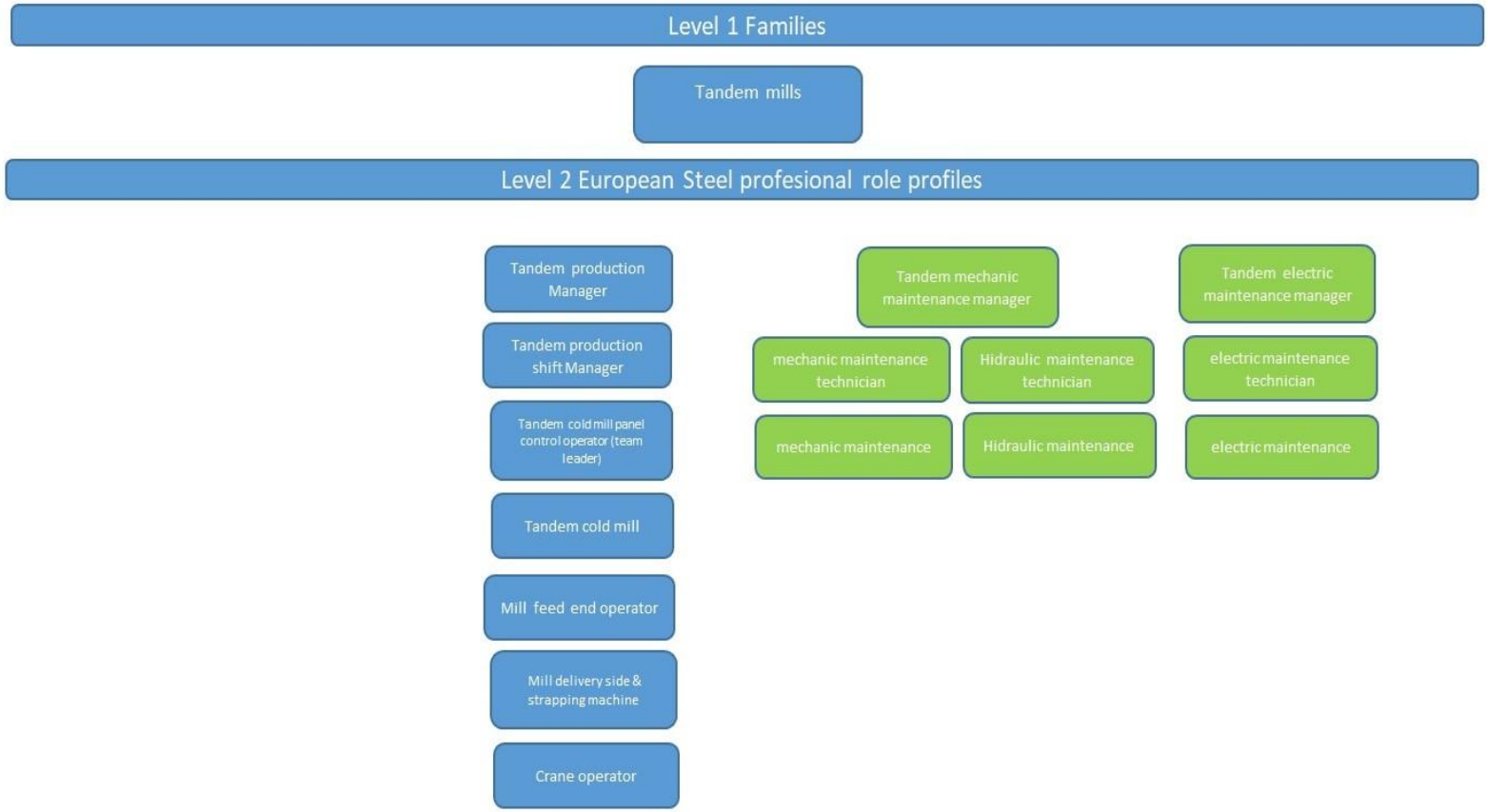
European STEEL SECTOR Professional Role Profiles: profiles (level 2) of Pickling Line Family at the downstream of the European STEEL SECTOR Profile Family Tree



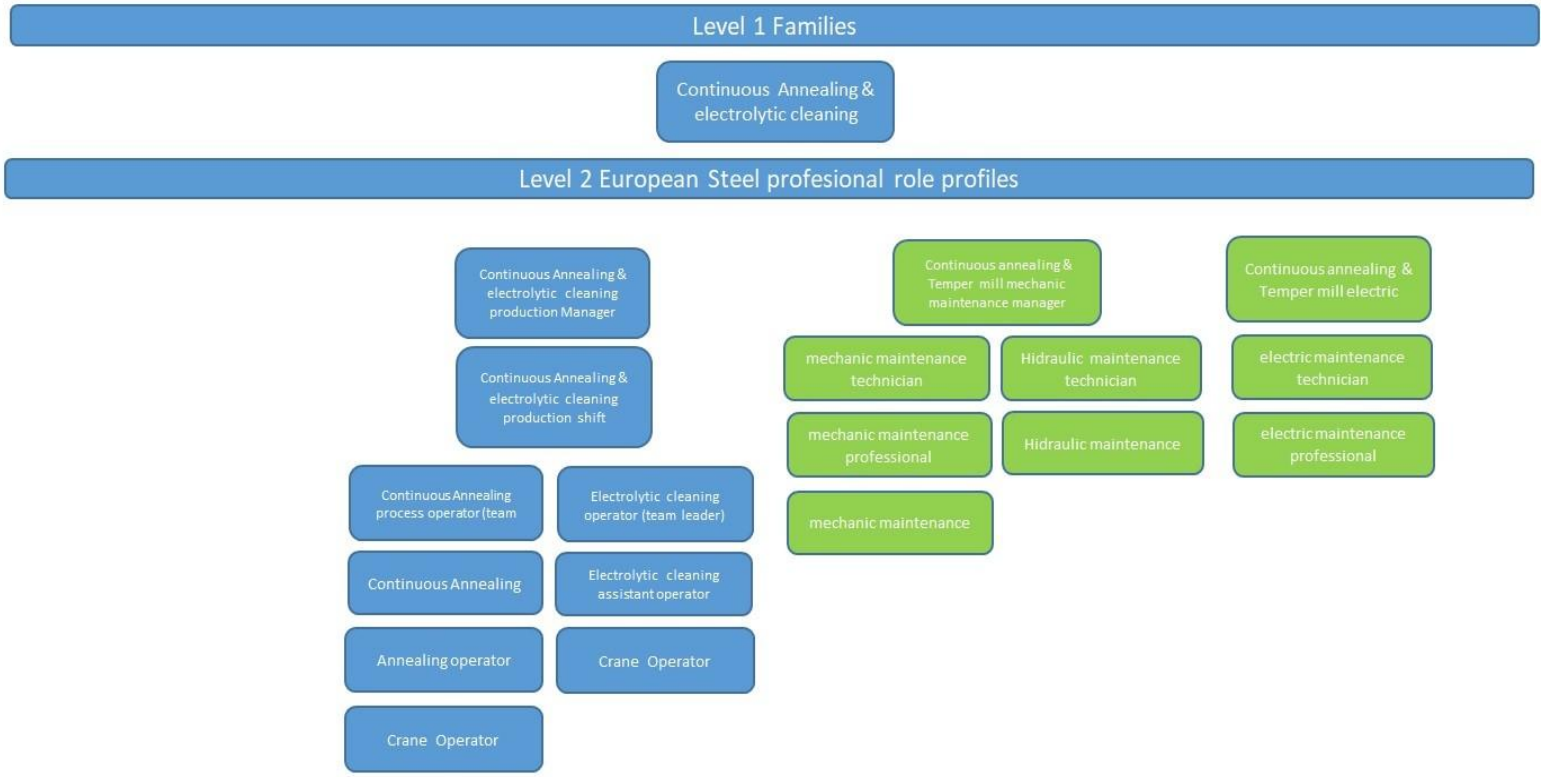
European STEEL SECTOR Professional Role Profiles: profiles (level 2) of Roll Grinding Shop Family at the downstream of the European STEEL SECTOR Profile Family Tree



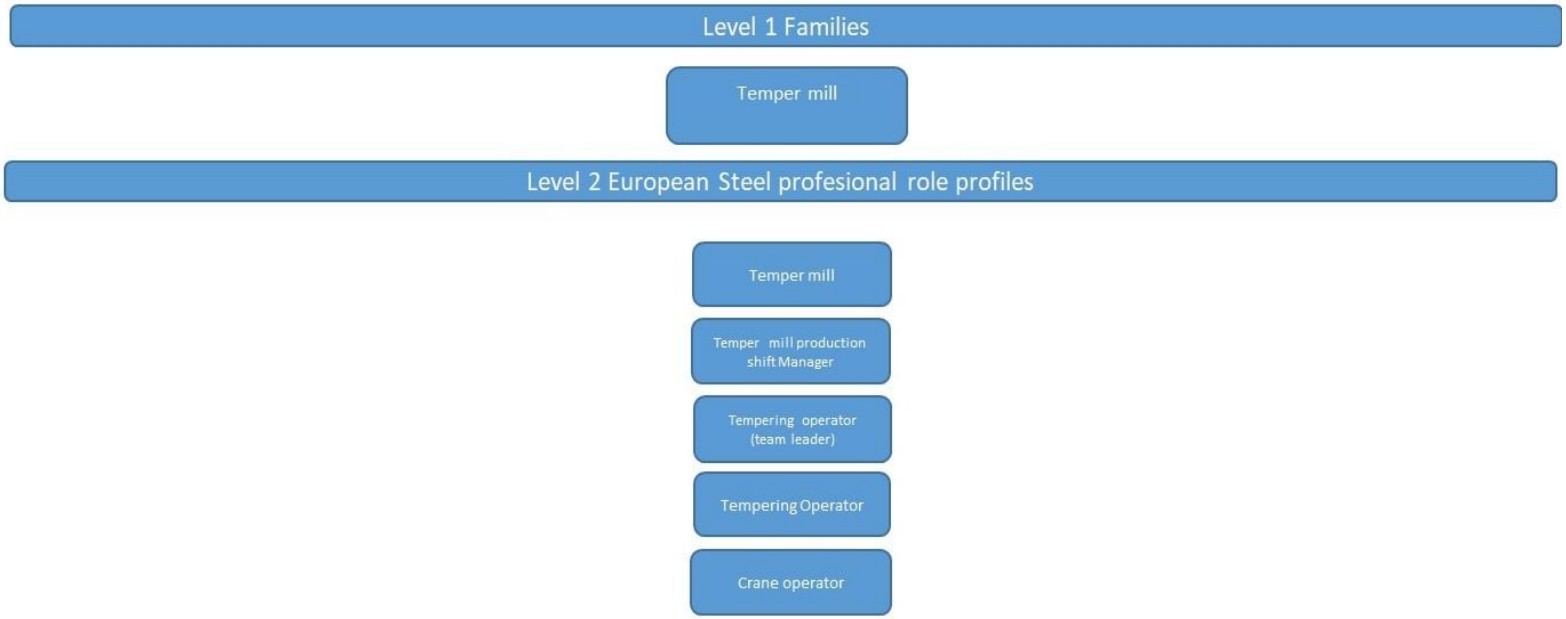
European STEEL SECTOR Professional Role Profiles: profiles (level 2) of Tandem Mills Family at the downstream of the European STEEL SECTOR Profile Family Tree



European STEEL SECTOR Professional Role Profiles: profiles (level 2) of Continuous Annealing and electrolytic Cleaning Family at the downstream of the European STEEL SECTOR Profile Family Tree

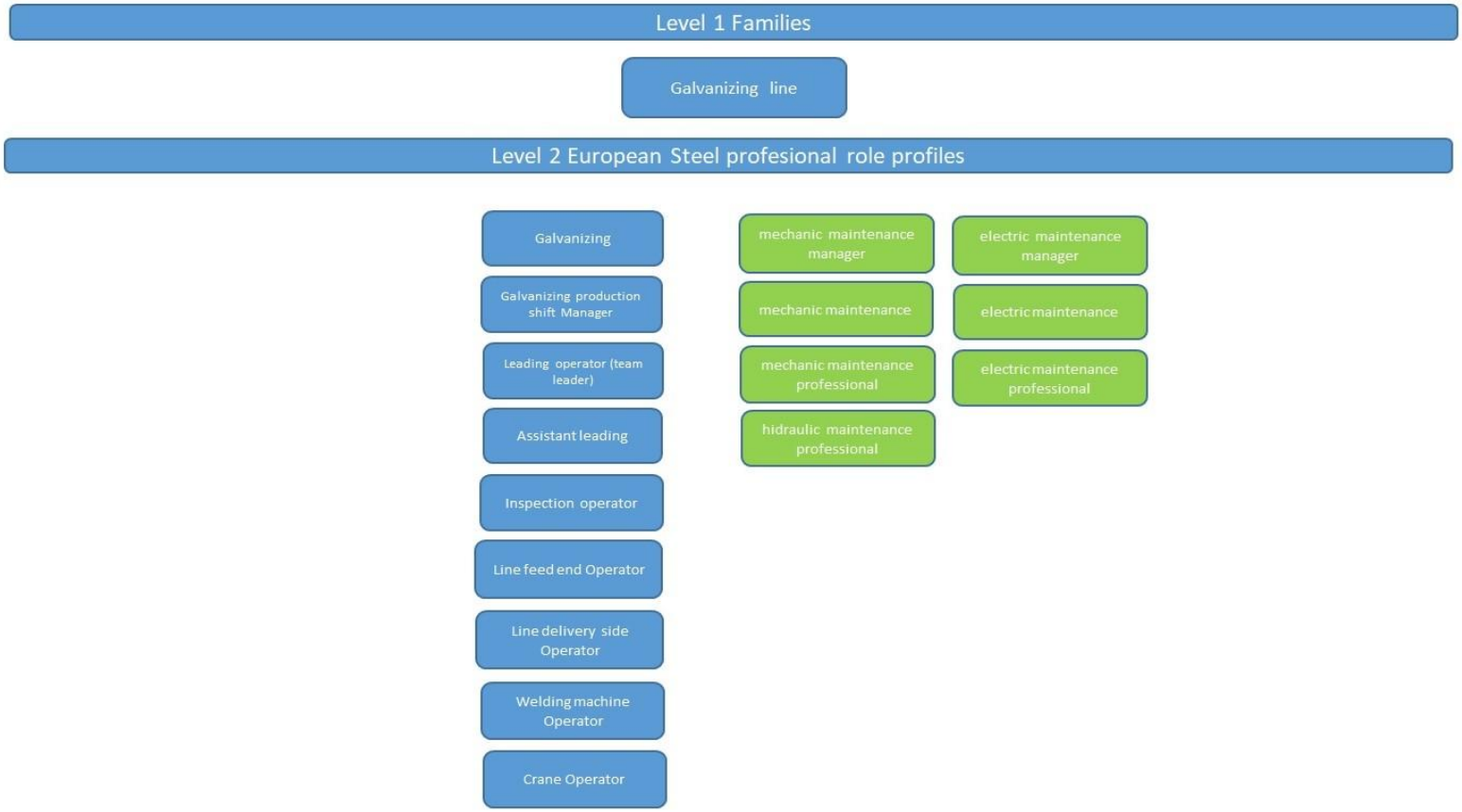


European STEEL SECTOR Professional Role Profiles: profiles (level 2) of Temper Mill Family at the downstream of the European STEEL SECTOR Profile Family Tree



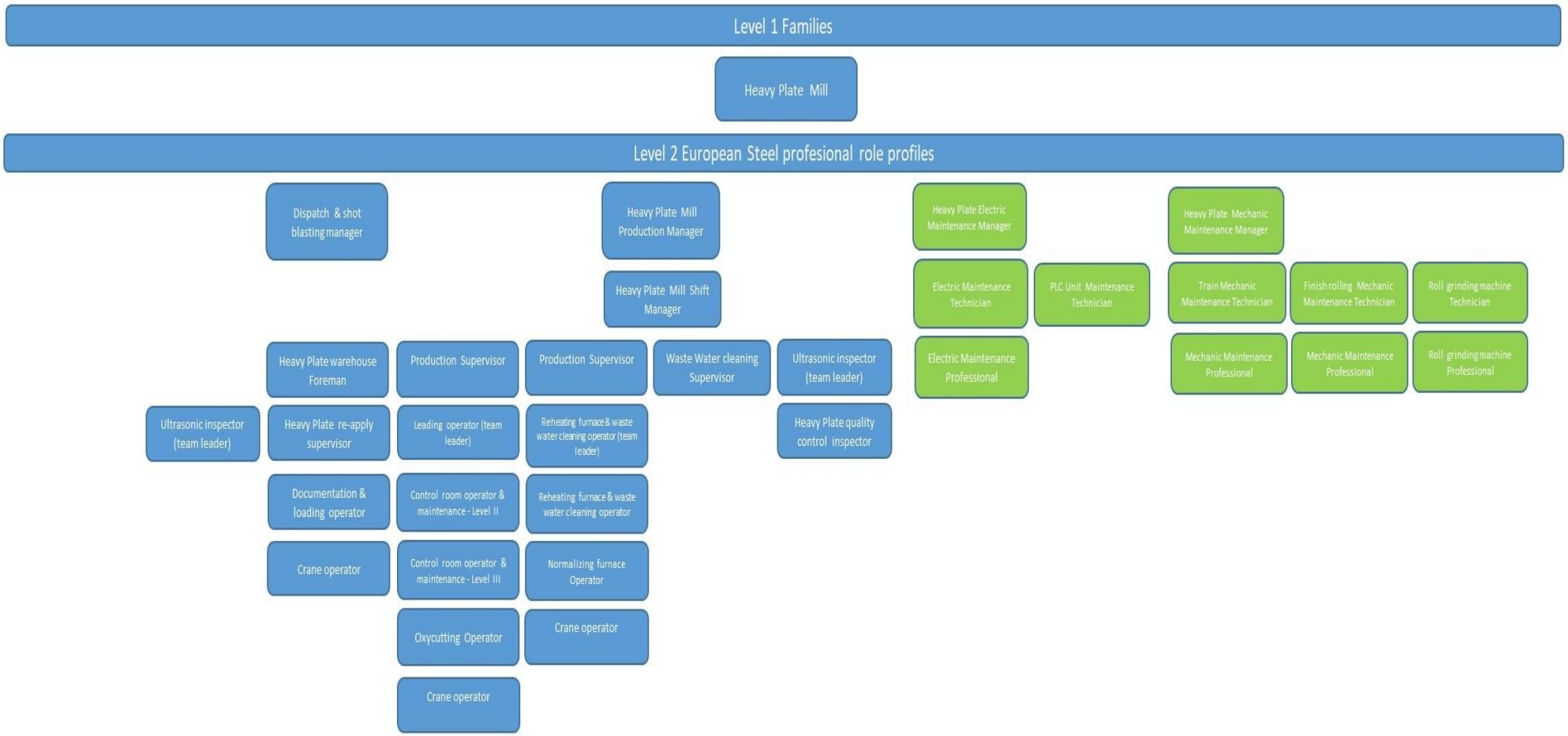
European STEEL SECTOR Professional Role Profiles: profiles (level 2) of Tin Plate Line Family at the downstream of the European STEEL SECTOR Profile Family Tree

European STEEL SECTOR Professional Role Profiles: profiles (level 2) of Galvanizing Line Family at the downstream of the European STEEL SECTOR Profile Family Tree

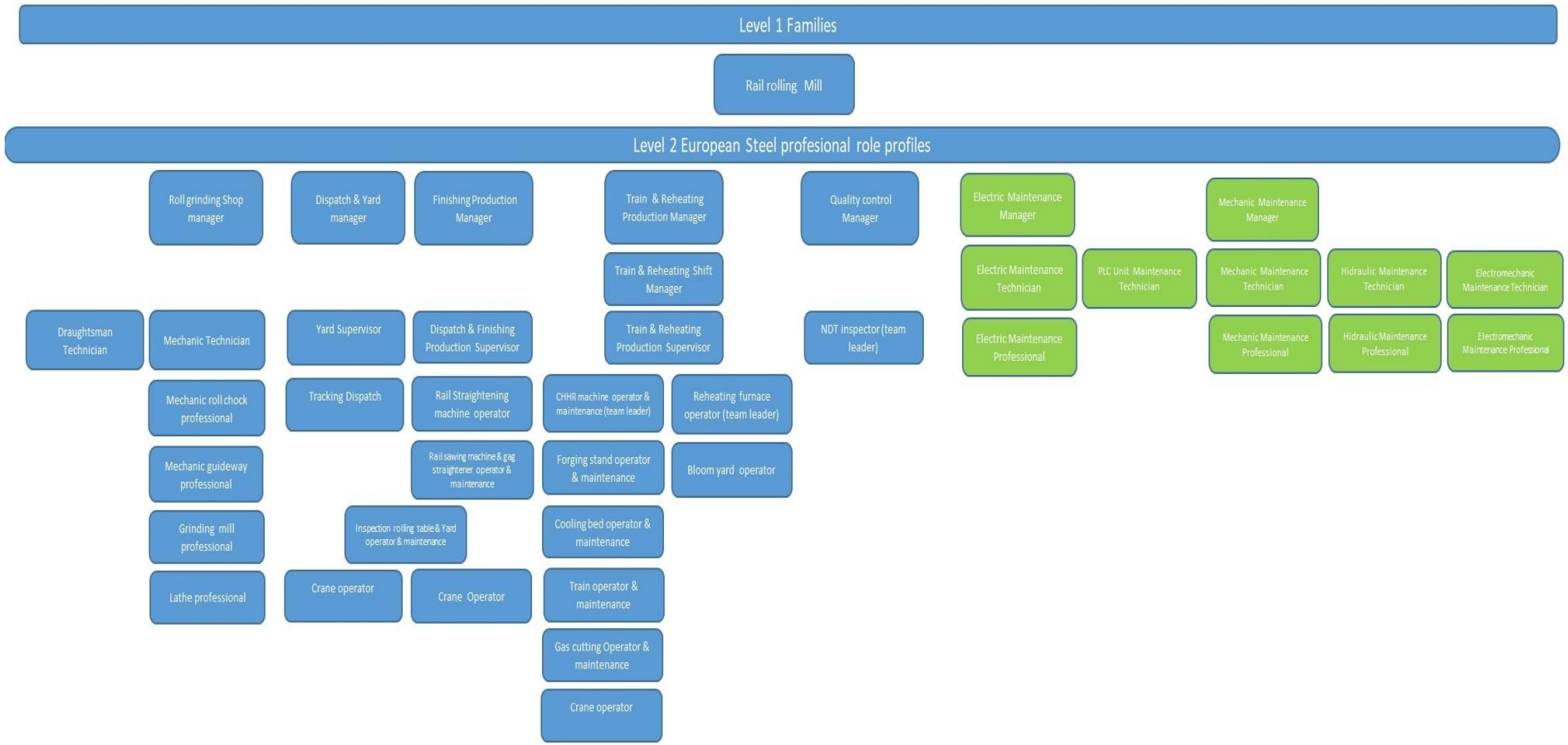


European STEEL SECTOR Professional Role Profiles: profiles (level 2) of Inspection and Flattening Family at the downstream of the European STEEL SECTOR Profile Family Tree

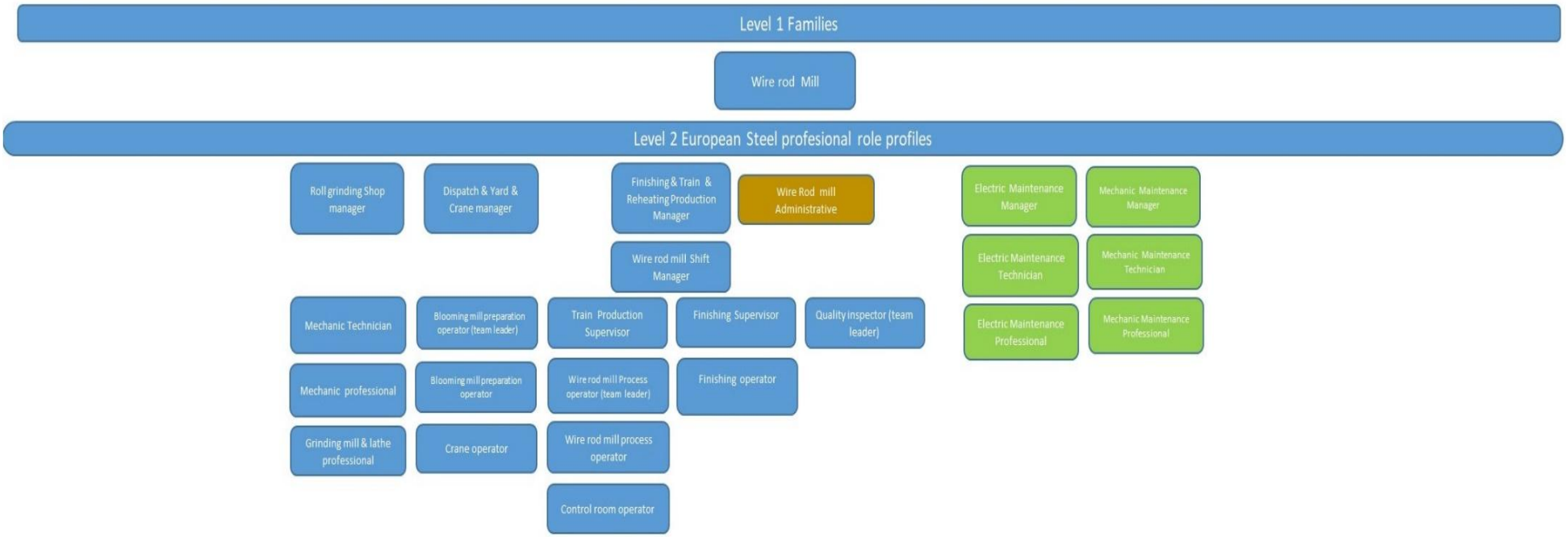
European STEEL SECTOR Professional Role Profiles: profiles (level 2) of Heavy Plate Mill Family at the downstream of the European STEEL SECTOR Profile Family Tree



European STEEL SECTOR Professional Role Profiles: profiles (level 2) of Rail Rolling Mill Family at the downstream of the European STEEL SECTOR Profile Family Tree



European STEEL SECTOR Professional Role Profiles: profiles (level 2) of Wire Rod Mill Family at the downstream of the European STEEL SECTOR Profile Family Tree



European STEEL SECTOR Professional Role Profiles: profiles (level 2) of Central Maintenance, Warehouse and Internal Transport Family at the downstream of the European STEEL SECTOR Profile

European STEEL SECTOR Professional Role Profiles: profiles (level 2) of Quality Control and Environment Laboratory Family at the downstream of the European STEEL SECTOR Profile Family Tree

European STEEL SECTOR Professional Role Profiles: profiles (level 2) of Electric Energy and Energetic Fluids Internal Control Family at the downstream of the European STEEL SECTOR Profile Family