Skills Alliance for Industrial Symbiosis: A Cross-sectoral Blueprint for a Sustainable Process Industry (SPIRE-SAIS)

Blueprint New Skills Agenda Energy Intensive Industries

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Executive Summary

In order to get a common perspective on the Blueprint and the integration of the different sectors and stakeholders, SPIRE-SAIS analysed the current state of implementation of Industrial Symbiosis and Energy Efficiency concepts in the European process industry and the related skills needs.

Cross sectoral developments of **Industrial Symbiosis (IS)** to be considered are not only the use of recycled products and transformed materials but also transaction services between industries offering new (shared) market solutions, business and cooperation models (to reduce production costs, implement new jobs, and include external customers). Additionally, there are data management opportunities for product customization, new decision and management tools to improve Industrial Symbiosis. Another dimension is sustainable development in a region, guidance to local and regional authorities and promotion of public dialogue processes to ensure regional action plans as well as interregional learning and capacity building.

Energy Efficiency (EE) developments focus on new technologies, systems and synergies between companies to optimize energy consumption and production to reduce the use of fossil fuels and the carbon footprint of industry as well as the investment, maintenance, and management costs of the energy infrastructure. Technology transfer and application is taking advantage of the best available technologies including digitalisation, integrated control systems, artificial intelligence, consumption measurement and preventive maintenance. Replicable instruments for energy cooperation, business models, joint energy services for industrial parks are elaborated. Amendments to existing regional/national/EU policies and legal frameworks to facilitate energy cooperation/services at all governance levels are in place as well.

In the context of these technological and economic developments, workforce adaptions for Industrial Symbiosis and Energy Efficiency is mainly characterised by multidisciplinary approaches, based on green and digital skills and new skills to manage the complexity of cross-sectorial cooperation in IS and EE implementation. The pro-active skills strategy needs to consider both technical as well as soft skills for a mainly incremental and complementary *upskilling of existing occupations and job profiles*, also considering *additional job profiles* (such as the IS Facilitator). The skills demand for Energy Efficiency is lower than for Industrial Symbiosis (higher demand). Managerial (business and regulatory) and operational skills (technical, transversal/individual) are required.

Against this background, the sector associations and companies involved in SPIRE-SAIS defined the industry driven skills demands by examining the range of essential job profiles and skills, knowledge and experience that workers need to adopt Energy Efficiency and Industrial Symbiosis in their daily work in the different industrial sectors. Based on the main *facts and figures and the organisational flow charts* in different sectors, job profiles related to Industrial Symbiosis were selected and grouped, equivalences with occupations in the ESCO database and ISCO groups were identified, while related skills were selected and grouped into a sectoral overarching *skills classification, complemented* by a first skills *assessment template*.

Key findings and impact for the Blueprint from a VET perspective are the low educators' readiness to teach green skills effectively, the lack of an evidence base to assess and replicate good practices and courses, the lack of a cross-sectoral IS/EE module to be integrated into different vocational training courses, including didactic materials and guidance for education providers, as well as a unified system for skills recognition. Another important barrier is the lack of a coherent policy: fragmentation of the responsibility for green skills delivery and lack

of an overarching strategy, funding tends to be fragmented and short-term. With a combined matrix of cross-sectoral IS and EE skills, SPIRE-SAIS tends to “connect” different concepts including job profiles, occupations, and qualifications and to identify how IS and EE related skills needs are addressed in relevant VET programmes. The matrix is expected to be most useful for the representatives of the industry and VET providers (e.g. interlinking circular job profiles with national occupations) by (1) linking job profiles, occupations and qualifications, (2) assessing the relevance of VET programme, and (3) integrating EU frameworks into national systems. The main challenge is to transform and digitalise the Cross-Sectoral Skills-Set Matrix into the interactive online platform SKILLS4PLANET and to roll it out to other countries. First steps have been taken, but need to be further elaborated, especially by integrating more Member States than the pilot countries (Germany, Italy, Portugal).

The SPIRE-SAIS Blueprint takes up these results through the establishment of Skills Intelligence via a Foresight Observatory, the online training platform SKILLS4Planet and a (to be developed and established) European Training Community for Industrial Symbiosis. These core elements are integrated and aligned with the broader European Community of stakeholders, programs, tools, and projects related to skills. Leadership is defined in an Open Coordination way, dividing responsibilities between the main and willing actors. Within the *Foresight Observatory,* technology and skills foresight will be carried out on a regular basis, including a (bi-)annual survey "*Industrial Symbiosis Technology and Skills Radar".* Recommendations, self-assessment tools, indicators and incentives were developed, putting the focus on qualifications, competences and skills for Industrial Symbiosis and Energy Efficiency. A repository gives an overview of IS and EE relevant research and education projects, image campaigns for recruitment and talent attraction will be addressed, pilot measures and testing possibilities will be supported, including the search for (European and national) funding schemes.

The SPIRE-SAIS consortium and associated partners bring together the **full range of stakeholders** required to establish a sustainable cross-sectoral strategic Skills Alliance, covering all A.SPIRE sectors and scoping twelve European countries from Northern, Eastern, Western and Southern Europe. However, through the European sectoral associations we cover all the Member States with Energy Intensive Industries. This has ensured and will continue to ensure a European-wide rollout of the SPIRE-SAIS Blueprint, engaging with national VET systems and cross-sectoral European frameworks. The partnership includes key industrial associations of all engaged sectors (Chemicals, Steel, Minerals, Aluminium, Water, Engineering, Ceramics, Cement, Refinery, Pulp & Paper), and other key actors (companies, training providers and research institutions) involved in actual and forthcoming projects of Industrial Symbiosis, Energy Efficiency and VET (skills and qualification needs and solutions). The partnership (consortium and associated partners) is based on and feeds the HORIZON EUROPE Public Private Partnership Processes for Planet (www.spire2050.eu/), which includes and is coordinated by A.SPIRE, the co-leader of SPIRE-SAIS, with more than 170 members (companies, training providers, research institutes) and 20 European countries.

SPIRE-SAIS Blueprint is not a stand-alone solution. The Blueprint strategy is led by a cooperative and shared responsibilities and leadership approach. The Foresight Observatory, the SKILLS4Planet and the European Training Community support activities related to European Energy Intensive Industries:

- Sustainable Process Industry through Resource and Energy Efficiency (A.SPIRE) and its recent activities, namely "Processes for Planet" (P4Planet) (see ASPIRE, 2021) and its governance structures and working groups

- Key stakeholder groups (social partners, sector associations and unions, policymakers, education system actors, etc.)
- The cooperation with the European Community of Practice for Industrial-Urban Symbiosis and Regional Hubs for Circularity and Industrial Urban Symbiosis (https://www.h4c-community.eu/)
- Other European networks and projects: e.g. the CircLean Network and Circle Economy, the INSIGHT project to establish the profile/occupation of the IS Facilitator
- European programs: European Pact for Skills and the Large Scale Partnership Energy Intensive Industries (LSP EII); CEDEFOP Skills Intelligence Platform; European Skills, Competence, and Occupation Database (ESCO)

In this sense, we see *skills as the missing link for Industrial Symbiosis activities of the different sectors, opening a common ground for collaboration beyond competitiveness, and unfolding the potential of new technologies and measures for Industrial Symbiosis and Energy Efficiency in the company workplace, closely linked with the workplaces of other companies.*

SPIRE-SAIS has established a European Training Platform SKILLS4Planet connected to other similar platforms such as the ESSA steelHub and linked to the European Community of Practice Hubs for Circularity (ECoP H4C). With the Skills Intelligence tool and the European Training Platform for proactive skills assessment and adjustments an effective and sustainable Foresight Observatory will analyse continuously and proactively skills gaps. The Online Training Platform SKILLS4Planet provides up-to-date support and knowledge to energy intensive industries by collecting and developing up to date training modules and tools for Industrial Symbiosis and beyond. The first sectoral and regional rollouts included public authorities and policy makers, big companies and SMEs, social partners, educational organisations and training providers, as well as civil society (organisations). Through the ECoP H4C, a connection and networking of regions with hubs for circularity has started not only for exchanging tools and knowledge across regions, but also to improve mutual learning and not reinvent the wheel several times new.

The Online Training Ecosystem SKILLS4Planet provides the infrastructure for a European/global exchange of training content, integrating inputs from and serving offers to industry associations and companies, VET systems, research centres, other Blueprints, European tools, and the non-formal and informal learning of individuals. SKILLS4Planet also serves National-Regional Training Eco-Systems, linking European, sectoral and regional training, and online as well as work-based learning.

SKILLS4Planet is an open online system. Based on a business model (agreements between the training publishers and the runner of the platform worldsteel) every training provider, could offer training which could be used by every interested company, VET institution, association and individual learner. The main components of the platform are (1) a Learning Solution Directory, (2) a Skills Directory, (3) a Capability Assessor, and (4) the integration into different learning and training pathways and settings.

The Online Training Eco-System SKILLS4Planet is complemented by a Sectoral-National-Regional Training Eco-System approach lightning the focuses on the "real" place where people live, learn and work. This comprises not only the important company training and learning activities including work-based learning but also the integration of VET institutions, policy, public authorities, research and science, and civil society activities within an ecosystem considering the responsibility, competences and activities for VET within a region.

The SPIRE-SAIS rollout targeted both the sectoral and the regional levels and was organised in the form of pilot workshops and round table discussions with stakeholders from the respective sectors and regions. Roughly summarised, the main objectives of the rollout were to disseminate SPIRE-SAIS results (including the SKILLS4Planet platform, the training courses and the identified skills/job profiles), and to promotion of sectoral-national-regional cooperation and processes on skills development and training for Industrial Symbiosis (IS) and Energy Efficiency (EE). At the same time, feedback on the actual challenges of individual sectors and regions were obtained in order to further refine the SPIRE-SAIS tools accordingly. The SPIRE-SAIS rollout is intended to be the starting point for a sectoral or regional development and a related social innovation process. It is therefore expected that not only one workshop round will be held, but that further events will follow and that the individual stakeholder groups will continue to work together on a permanent basis even after the project duration of SPIRE-SAIS.

So far, rollout workshops have been held in five sectors to date: In the first half of 2023, workshops were held in the steel, minerals and chemicals sector. In March 2024, a rollout workshop took place in the water sector, and in April 2024 in the engineering sector. In addition, two regional workshops were held in the Italian region of Emilia-Romagna and in the Basque Country in Spain. Rollouts for the aluminium sector and the ceramics sector are planned for the second half of 2024. Discussions in the rollout workshops indicated a clear need to improve the awareness for Industrial Symbiosis and to simplify the theory with practical examples while demonstrating applicability. One of the main challenges for the uptake of Industrial Symbiosis is the lack of connections between companies, especially in terms of information and communication. There also seems to be a lack of channels and connectors. The rollout workshops also showed that talent attraction and recruiting, as well as constantly updated training are among the main tasks and challenges in Energy Intensive Industries with regard to Industrial Symbiosis.

Based on the lessons learnt from the sectoral and regional rollout processes SPIRE-SAIS aims to establish a European-national-regional European Community of Practice for supporting National-Regional Training Ecosystems, exchange good practices and mutually learn from each other. Follow-up activities of the rollout activities will focus on (differently taken up and prioritised by sectors, countries and regions):

- Image and Recruiting: New Narrative of the Energy Intensive Industries
- Digital and Green Transformation: Hydrogen Usage and Impact on Skills
- SKILLS4Planet interlinks to regions, including how to combine online and on-the-job, work-based learning
- Specific sectoral skill needs and adjustment strategies going beyond Industrial Symbiosis.

In addition to the already ongoing cooperation with ESCO for the exchange of job profiles and related skills demand, the Blueprint engages with other European tools: such as ECQA (European Certification and Qualification Association) and Micro-credentials for certification of skills and training modules with SKILLS4Planet , the Skills Intelligence of CEDEFOP (see more here: Cedefop, 2019) to share our results with the wider VET and industry community, and Europass to collect learning outcomes for the individual learners.

With the introduced Industry 5.0 concept the European Commission is aiming to move towards a human-centric orientation in the workplace. For this purpose, the Commission has already been actively developed directives, frameworks, action plans, and communications to ensure the main rights of workers, such as health and safety at work and equal opportunities for

women and men. The policy recommendations created by SPIRE-SAIS align with these directives. SPIRE-SAIS policy recommendations have been divided according to the level of addressed stakeholders, such as European, national or general (overarching).

SPIRE-SAIS together with the European Steel Skills Alliance (ESSA) is since May 2023 part of the **Large Scale Partnership Energy Intensive Industries (LSP EII)** under the Pact for Skills. With this pact we are looking for a sustainable development of SPIRE-SAIS under a common, different process industries comprising framework with three specific Blueprints as a starting point:

- SPIRE-SAIS = **cross-sectoral** and **Industrial Symbiosis skills** specific blueprint
- ESSA = **specific sector** related blueprint including an incremental upskilling of representative job profiles (t-shaped skills: technical and transversal skills (green, digital, social, individual, and methodological))
- Added by the recently launched ChemSkills Blueprint encompassing skills for the **digital and green transition of the chemicals sector**.

With an overarching Skills Alliance for the Green, Digital and Social Transformation of the Energy Intensive Industries (Skills4EII) proposal, we will build on the results of the European Steel Skills Alliance (ESSA) and the Skills Alliance for Industrial Symbiosis (SPIRE-SAIS) within the further development of the Large Scale Partnership Energy Intensive Industries (LSP EII) as part of the European Pact for Skills. It is essential part to identify and adjust additional cross-sectoral and sector specific skills gaps for specific sectors and national-regional skills and training ecosystems. With such a common framework we will focus more in-depth on specificities of the different sectors. Expanding the results of the blueprint projects by closing skills gaps for specific (additional) sector needs (e.g. SME specific skills in the ceramic sector) and using synergies for cross-sectoral relevant topics and activities (such as Image & Recruitment, cooperation for the exploitation of Industrial Symbiosis, Industry 5.0, Artificial Intelligence) are in focus. It is essential to open and scale up the challenges and gaps already identified and those still to come in a more general scope (beyond steel and Industrial Symbiosis), focusing on the one hand on the specific needs of the different industrial sectors (Steel, Minerals, Water, Engineering, Logistics, Non-Ferrous Metals, Ceramics, Raw Materials, Chemicals, Cement, Pulp & Paper, Refinery). On the other hand, the rollout to existing and new **national-regional ecosystems** is key. A central element to support this is the planned online training platform HUB 5.0 (integrating the ESSA steelHUB and the SPIRE-SAIS online platform SKILLS4Planet). Furthermore, taking the next steps towards a Process Industry 5.0, that is more human-centric, sustainable, and resilient is key.

1 Introduction

The description of the SPIRE-SAIS Blueprint is based on the project results related to technological developments, industry skills requirements, Vocational Education and Training System (VET) support, a training framework and the establishment of the online training platform SKILLS4Planet, implementation and sectoral-regional rollout activities as well as recruitment and image strategies. Summarising the results from the perspective of a comprehensive and interrelated European Skills Strategy and Alliance to support and improve Industrial Symbiosis and Energy Efficiency by proactive skills adjustment, the outcomes were integrated in a common picture (Blueprint). Reflecting the background, its programmatic orientation and lessons learned during the project, the Blueprint outlines its relevant elements and related strategies, tools, implementation and rollout activities as well as policy recommendations as practical guidelines.

1.1 *Background*

In line with the European New Skills Agenda, the Pact for Skills and the series of Sectoral Blueprints the project developed a Blueprint “European Energy Intensive Industry Skills Agenda and Strategy (SPIRE-SAIS)” for an ongoing and short-termed implementation of new skills demands concerning *cross-sectoral* Industrial Symbiosis (IS) and Energy Efficiency. Against this backdrop, the implementation of the SPIRE-SAIS Blueprint strategy was performed already in its proposal phase as a *Cross-Sector Skills Alliance on Energy Intensive Industries*. It started as a (social) innovation process by involving a broad range of key stakeholders from the eight sectors of the public-private partnership A.SPIRE (Sustainable Process Industry through Resource and Energy Efficiency): Steel, Chemicals, Minerals, Non-ferrous Metals, Water, Engineering, Ceramics, and Cement - during the course of the project completed by two new SPIRE sectors: Refinery and Pulp & Paper. This alliance of related industry associations, technology platforms, training providers, and research partners is characterised by a huge competence based on a long list of projects for Energy Efficiency, Industrial Symbiosis (IS) and related Vocational Education and Training (VET) projects, in which they are engaged. 13 associated partners join the 24 consortium partners, showing the high interest of the industries and setting the ground for addressing cross-industry skill demands and challenges, focusing particularly on people and skills necessary for the implementation and improvement of Industrial Symbioses and Energy Efficiency.

Two principal objectives are supported by an underpinning strategy framework:

1. Proactive identification of skill needs and demands for building appropriate training and curricula, including new vocational education content and pedagogies across the sectors (thus enabling mutual recognition of skills and training), within both companies and education and training institutions.
2. Identification, development and promotion of successful sectoral recruitment and upskilling schemes, including a first training framework for efficient management of knowledge towards high skilled workers, and tackling recruitment difficulties (e.g. industry attractiveness) for widening the talent pool and establishing a more diverse workforce.

These two objectives are reinforced by:

1. Establishing a database of industry occupations, job roles and skill requirements for facilitating recruitment, job-seeking, skills and training provision at the local, member-state and EU sector level, and skill needs analysis.
2. Securing political support measures through the Skills Alliance for mobilising and integrating (sector) stakeholders and policy makers at the EU and member-state level.
3. Developing Performance Indicators and Key Performance Indicators, within the remit of an established Skills Alliance, for monitoring success continuously in respect of objectives (1) and (2), as well as the proactive adjustment of SPIRE-SAIS for addressing emerging challenges, including monitoring issues.

To reach these objectives, a common ground of the partnership for “intercultural” exchange between the different industry sectors and the different qualification levels (blue and white collar, and green skills as overarching issue) within a common social innovation process of co-creation and mutual learning was initiated. To ensure cross-sectoral cooperation a Steering Committee “Sector Responsible” comprising all the relevant A.SPIRE process and energy intensive industry sectors (including also representatives of two new sectors: Refinery and Pulp & Paper) was established as a central communication and dissemination intersection to improve and exploit the project results, to campaign awareness for cross-sectoral Energy Efficiency and Industrial Symbiosis and needed skills.

To reach these objectives, the work programme of SPIRE-SAIS (see Figure 1) is based on the analysis of the technological and economic developments in the involved industry sectors. Against this backdrop, a reliable framework and up-to-date setting for implications for the following work packages on industry skills requirements and VET system contexts and support has been ensured. These three building blocks are feeding into the Blueprint development to be transferred and implemented. On the background of the results of all the building blocks (mainly the blueprint and its implementation), policy recommendations as practical guidelines were elaborated and dissemination activities planned and conducted. Understood as a social innovation process including two iteration cycles the Blueprint *Prototype* was implemented and tested in 2022-2024 involving all the represented stakeholders. Based on the practical insights of the Prototype testing the underlying subject areas (technological development, skills requirements, and VET system support) were updated with new developments, all in all leading to an improved Blueprint and related deliverables finalised in 2024.

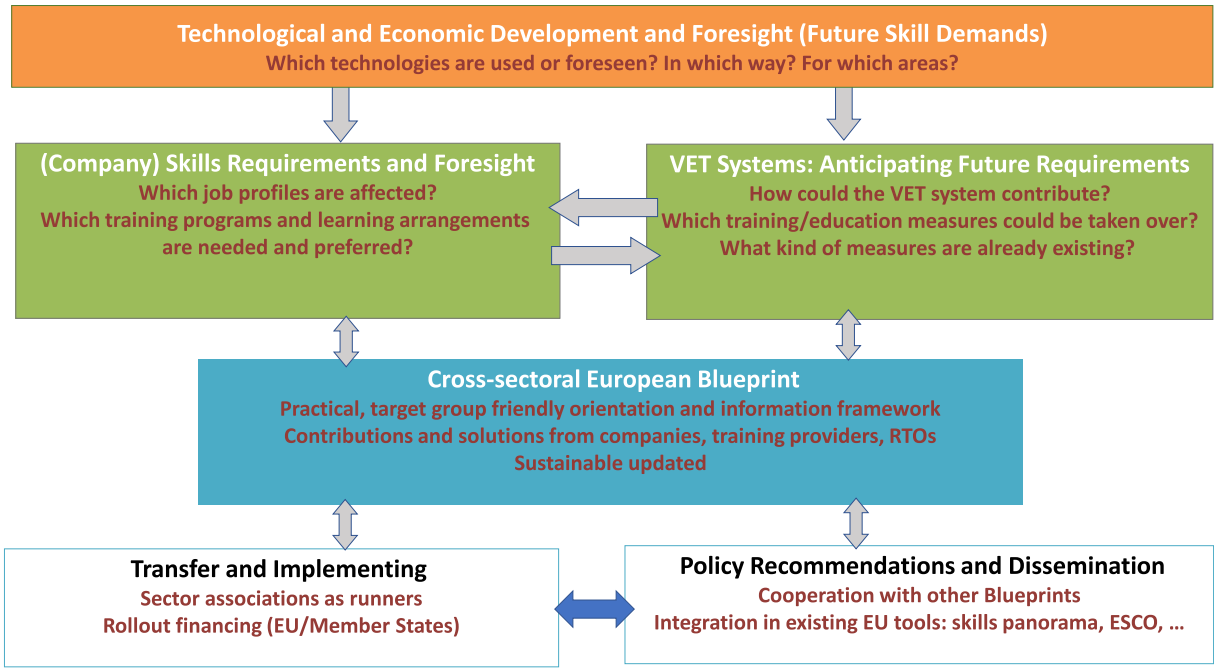


Figure 1: Structure and Work Programme of SPIRE-SAIS.

1.2 *Programmatic Orientation and Blueprint Outline*

The SPIRE-SAIS Blueprint is *driven by the industry* perspective as the core of our activities. Additionally, it is dedicated to combine technological and social innovation in a *human-centric approach* as described in the DG R&I Policy Brief Industry 5.0 (Breque et al., 2021, p. 2): "Against the backdrop of the implementation of the broad range of Industry 4.0 technology the workers are confronted with changing roles and increased reliance on complex technologies. Upskilling of the workforce includes therefore also workers empowerment, challenging their traditional education life cycle of training, work and retirement. Technological development has to be complemented with the cognitive, experience and practical based skills of the workers, already in the technological innovation development phase - leading to more responsibility for and increased supervision of the production process, advanced "collaboration" between humans and robots."

"Rather than asking the industry worker to adapt his or her skills to the needs of rapidly evolving technology, we want to use technology to adapt the production process to the needs of the worker, for example to guide and train him/her." (Breque et al., 2021, p. 14)

Against this backdrop, skills are seen as a key **enabler and missing link for Industrial Symbiosis**, developing and establishing a common ground for cross-company and cross-sector collaboration beyond competitiveness for the sake of the environment. Taking up this challenge, SPIRE-SAIS as the only *industry sectors overarching* Blueprint so far is developing a common Blueprint focusing on a *cross-sectoral perspective of new or updated skills for Industrial Symbiosis and Energy Efficiency* linking demand with supply and coordinate skills adjustment:

A. The **demand side** (chapter 2):

- Continuously monitoring (within a biannual period) the *technological and economic demands and its related skills requirements* (see section 2.1)

- Ensuring an industry driven and defined skills adjustment by a generic *skills and central job profiles classification* (section 2.2)
- Align with existing *VET system occupations* as much as possible (section 2.3).

B. The **supply side** (chapter 3):

- Setting-up *strategies and measures* to ensure proactive and sustainable skills adjustments across and in the different industry sectors by:
    - Establishing a Skills Intelligence with a Foresight Observatory and Survey (Industrial Symbiosis Technology and Skills Radar) (section 3.1), including
        - a repository and exchange platform of training courses for Industrial Symbiosis and related Energy Efficiency
        - possibilities for pilot measures and tests (by taking advantage of European and national/regional funding opportunities: Horizon Europe, Processes for Planet, Erasmus+, ESF+, EFRE, and others)
        - incentives and/or awards for generating good/best practice
    - Creating a training platform for (new) training offers and appropriate learning arrangements (see D5.1; Muract et al., 2024),
    - Initiating and fostering image, recruitment, talent management strategies and campaigns to attract more (young) people for the process industry (section 3.3)

C. The **coordination side**:

- To sustainably run the Blueprint, *new alliances and governance structures* (chapter 4) have to be *aligned with existing European coordination and sector structures* (sector associations, social partnership), assigning decentralised leadership for the specific elements of the Blueprint on the European (cross-sectoral and sectoral) and national/regional level (sectoral, Hubs for Circularity). This leads to an improved level of cooperation between associations and social partners, companies, training providers and other stakeholder groups to promote the perspective of Human Resources as an enabler for technological development, implementation and exploitation (at the workplace).
- For the implementation and rollout of the Blueprint we have a close cooperation with the European Community of Practice for Hubs for Circularity (ECoP H4C) https://www.h4c-community.eu/ , by bringing in our Human Resources and Skills perspective.
  Through this collaboration we are disseminating the European SPIRE-SAIS activities to the Hubs for Circularity on the regional level.
  Additionally, we have integrated the Blueprint into relevant activities on the European level (New Skills Agenda, Pact for Skills, Cedefop's Skills Panorama and Skills Intelligence Platform, and others). Beside the European-Regional cooperation within the ECoP H4C the continuous roll-out of the Blueprint is concentrating on sector associations, including support to VET systems of the Member States, in joint actions with the Large Scale Partnership for Energy Intensive Industries (LSP EII) under the Pact for Skills and other sectoral industry Blueprints (batteries, steel, hydrogen, automotive, construction, and others), as far as this is feasible and possible.

The holistic and industry driven approach is represented on the demand side by a *Technology, Economy, Environment, and Societal Driven Skills Adjustment* as the genuine driver of new applications (implemented with specific company objectives) and collaboration measures, leading to organisational implications. The triangle of **technology - organisation - human** is

the frame for defining the new skills needs. The supply side reflects (a) the assessment of the affected industry job profiles within the related production and functional areas as well as the affected industry occupations (of the education system) and (b) related (private) training offers and education system support (via curricula of initial and continuous VET, tertiary education, aiming to identify gaps in the provision of certain skills categories). Especially from a recruiting perspective, the foundation for a better industry image and attractiveness and basic industrial skills must be laid as early as possible in pre-VET education (kindergarten, primary and secondary schools).

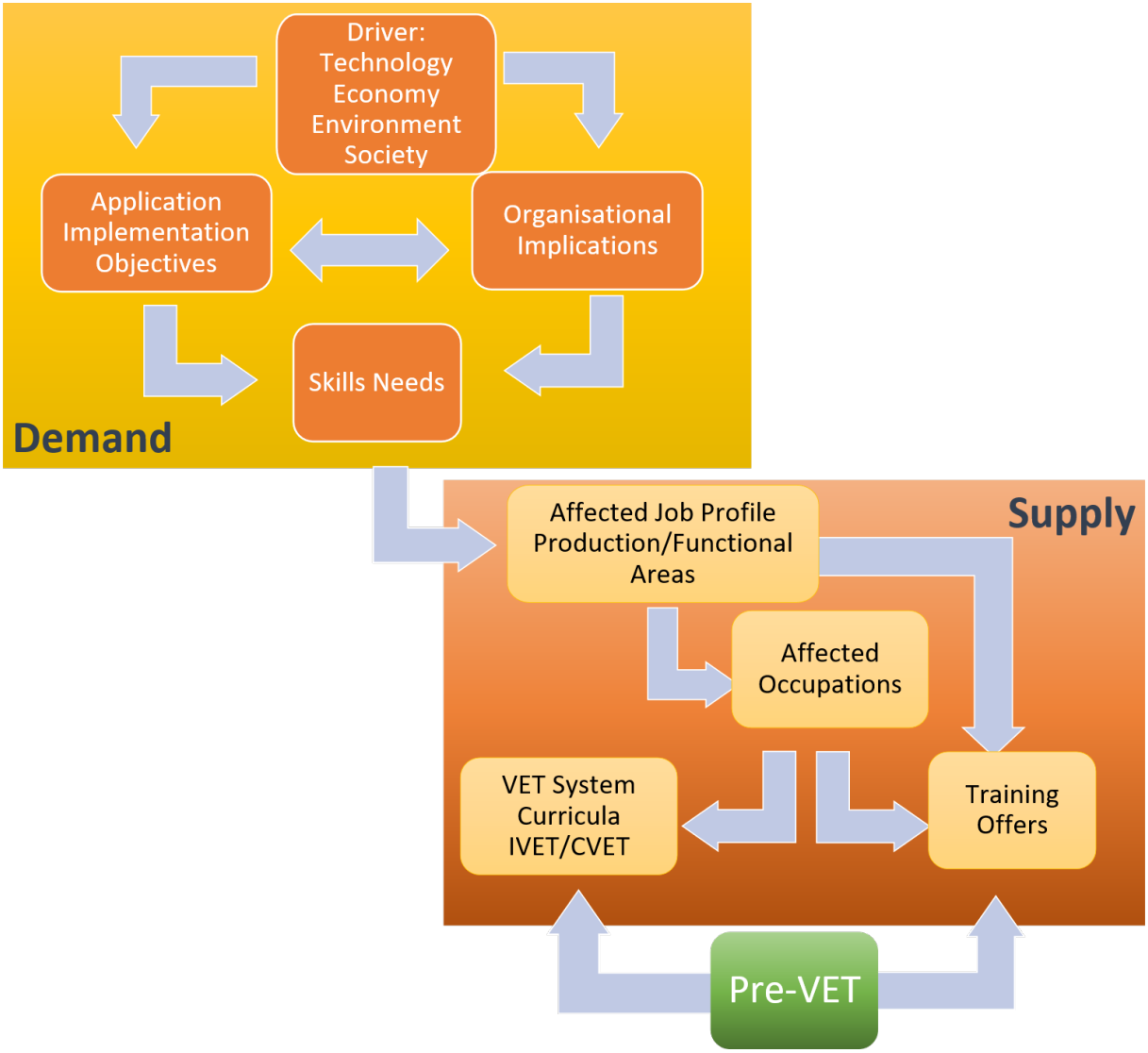


Figure 2: Demand and Supply Side

To ensure sustainability of SPIRE-SAIS and the integration of the different sector perspectives, the process of developing and implementing the Blueprint was organised as a *social innovation process*. This integrates relevant and intrinsic motivated stakeholders of different areas and proveniences (companies, research institutions, training providers, associations and social partners, civil society organisations) right from the beginning of the project in the consortium (including associated partners, willing to participate on their own costs). Starting with the **challenge** of adjusting Industrial Symbiosis and Energy Efficiency skills needs because of new technological and economic developments, environmental and societal demands, the **idea** of a cross-sectoral Blueprint funded by the Erasmus+ program was taken up. This leads to the **intervention** of setting up a first European Skills Agenda and Alliance on Industrial Symbiosis

and Energy Efficiency with interested stakeholders from companies, research, training providers, social partners (associations and unions), testing and improving the developed Blueprint in a cocreation process during an **implementation** phase, and setting the claims for **institutionalisation** and impact right from the beginning. Due to changing social practices, such a social innovation does not expect a linear development process, **iterative and cyclical feedback loops** were planned and considered to ensure an upgrading of the interventions and the implementation of the Blueprint during the project life span (see Figure 3).

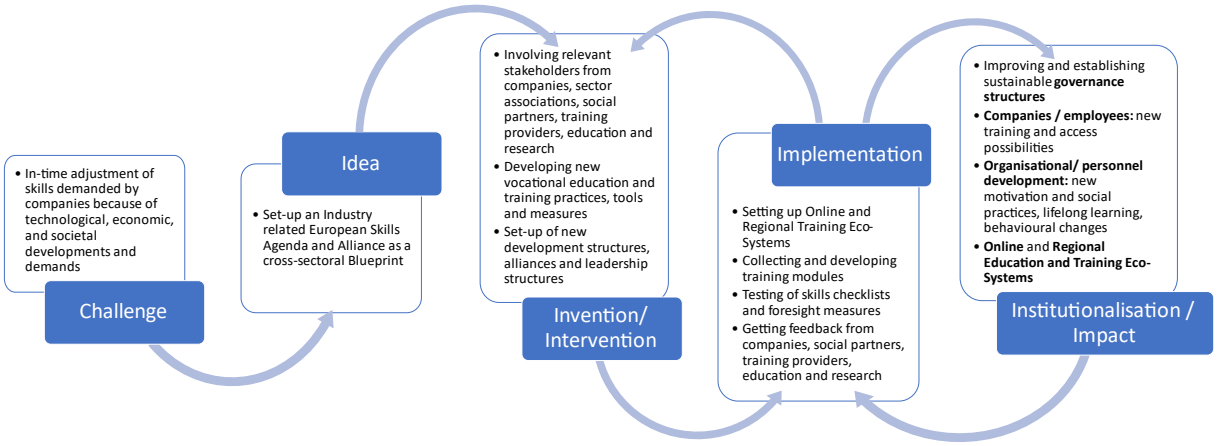


Figure 3: Blueprint Development and Implementation as a Social Innovation Process

2 The Demand Side: Industry Driven Skills Demands

As described before and shown in Figure 2, SPIRE-SAIS addresses both the demand and supply side for skills adaptation. The demand for proactive skills adjustments concerning cross-sectoral Industrial Symbiosis and Energy Efficiency is characterised by (a) the technological and economic developments and (b) the industry / company requirements of the different energy intensive industry sectors, listed in the following chapters. Besides desk research, workshops and meetings two surveys were conducted: (1) survey in 2021 with the focus on the technological developments and related skills demand (see chapter 2.1.3), and (2) survey in 2024 getting feedback on the selected job profiles (see chapter 2.2.3) and skills classification (see chapter 2.2.5).

2.1 *Technological and Economic Demands and Skills Requirements*

The analysis (see in detail D2.1; Branca et al., 2024) of the current state and future trends of the implementation of Industrial Symbiosis (IS) and Energy Efficiency (EE) concepts in European process industries, including the transactions of energy and material flows, has been done by (past and ongoing) funded EU projects, scientific literature, and official and public documents of the relevant SPIRE sectors (Iron and Steel, Chemical, Non-ferrous Metals, Mineral, Water, Cement, Ceramics, Cement and Waste treatment). In addition, the effects of IS and EE on the workforce have been considered and integrated in the documents, also including training/education projects: in general, this provides a basis for a complete state-of-the-art of IS and EE implementation in the process industries. The desktop analysis was completed by an online survey giving direct insights from the companies. Summarising the results different challenges for Industrial Symbiosis and related Energy Efficiency appear for the Blueprint strategy.

2.1.1 Technological Development

Industrial symbiosis aims at optimizing resources usage and reducing the quantity of by-products/waste generated in a “closed loop” in order to improve the environmental and economic performances. The symbiotic transactions involved include: the use of waste as inputs of other industries, transactions of utilities or access to services, and cooperation on issues of common interest. These result in higher Energy Efficiency and better results in the 4R approach for waste management (Reduce, Reuse, Recycle and Restore). The creation of synergies between companies can enable successful development ofIndustrial Symbiosis and providing benefits to all parties. In this process, companies develop a trust bond facilitating the supply resources. On the other hand, the implementation of the symbiosis network can also produce some problems for companies. Synergies between different industries can reduce the vulnerability of the network, increase its robustness, and reduce the possibility of failure. There is a strong ally for the achievement of environmental, economic and social objectives. In addition, the large number of recent activities focused on IS in the different analysed sectors have shown, although this process started in the last few decades, this process is growing rapidly. Ongoing and future researches on Industrial Symbiosis are focusing on the impact quantifications and existing synergies improvements as well as on the creation of new symbioses. Furthermore, it is important to overcome barriers and to quantify the total impact of this practice on companies, the environment and society, by considering different characteristics of the network and particularities of the region involved. This will result in decision-making methods for further and final decision-making process.

Energy Efficiency activities highlight the improvement of solutions to reduce energy use and environmental impact, as well as cost savings. Case studies and projects have demonstrated the methods of energy analysis and optimization, by analysing the suitability of energy strategies within Energy Intensive Sectors. As sources of energy loss, which are considered waste for one company may be a valuable resource for another one, it is important to identify and to implement the use of techniques and technologies for the production, use and recovery of energy. Synergies among companies can lead to the optimization of energy consumption and common production to reduce the use of fossil fuels and, consequently, the carbon footprint of industry as well as the investment, maintenance, and management costs of the energy infrastructure. This has been demonstrated in some cases, such as the steel sector, by reducing product life cycle energy use and emissions through improving product design, recovery and reuse, remanufacturing and recycling. The cooperation among different industrial sectors can help overcome the lack of technical knowledge regarding low carbon and renewable technologies as well as cost savings. In addition, the main challenges identified by this analysis have highlighted further improvement in Energy Efficiency. In the steel sector, for example, the best available steelmaking processes have optimised energy use. In the future, Energy Efficiency improvements in Energy Intensive sectors are expected through technology transfer and by applying best available technology. In addition, a suitable energy system model should include the following features: multi-objective optimization, in order to facilitate minimisation of both costs and carbon emissions; the technology description at unit level; sufficient temporal detail, showing energy demand; energy storage technologies and flexible energy demands; the system superstructure, enabling the introduction of energy service demand or energy production technology.

Cross sectoral developments of *Industrial Symbiosis* to be considered are not only the use of recycled products and transformed materials as raw materials for manufacturing new products. They also include (product, network, private and public) transaction services between

industries offering new (common) market solutions, business and cooperation models (for reducing production costs, implementing new jobs, and including external customers). Additionally, there are data management opportunities allowing product customization, new decision and management tools to improve Industrial Symbiosis are in place. Another dimension is the sustainable development in a *region*, guidance to local and regional authorities and promotion of public dialogue processes to ensure regional action plans as well as interregional learning and capacity building. *Energy Efficiency* developments are focusing on new technologies, systems and synergies among companies to optimize energy consumption and production to reduce the use of fossil fuels and the carbon footprint of industry as well as investment, maintenance, and management costs of the energy infrastructure. Technology transfer and application are taking advantage of the best available technologies including digitalisation, integrated control systems, artificial intelligence, consumption measurement, and preventive maintenance. Replicable instruments for energy cooperation, business models, joint energy services for industrial parks are elaborated. Amendments to existing regional/national/EU policies and legal frameworks to simplify energy cooperation/services at all levels of governance are in place as well.

2.1.2 Workforce Development

In the context of these technological and economic developments, the *workforce adjustment* for Industrial Symbiosis and Energy Efficiency is mainly characterised by multidisciplinary approaches, based on green and digital skills and new skills to manage the complexity of cross-sectorial cooperation in the implementation of IS and EE. The pro-active skills strategy must consider both technical and soft skills:

- **Industrial Symbiosis skills**: communication and information, co-creation and cooperation with other sectors and local stakeholders and authorities, managing diversity to engage different stakeholders, materials and recycling know-how, fostering financially attractive pathways with a strong positive environmental impact.
- **Creating IS facilitator** profiles: esp. new skills for networking, collaboration, system thinking, legislation (environmental economics & policy), specific skills for waste & recycling, environmental improvement, entrepreneurship, financial, marketing and management skills, Material Flow Analysis & Life Cycle Assessment, Marketing, and IT skills.
- **Energy Efficiency:** green skills for the transition to a low-carbon economy; skills for managerial and technological changes, specific sectoral skills, integration of Energy Efficiency into daily operational practice in a continuous process, requiring additional skills, and interdisciplinary knowledge related to: energy management, renewable energy sources; energy auditing, building and facility management; energy trading, economics, financing, production planning and maintenance.

2.1.3 Survey Results

SPIRE-SAIS conducted two surveys (2021 and 2024) with different foci.

- Technological maturity and implementation of IS and EE (2021) (described in detail in Deliverable D1.5 (Schröder, Branca, Colla, et al., 2024) in chapter 2.3.3)
- Evaluation of the selected job profiles and skills classification (2024) (described in detail in Deliverable D1.5 (Schröder, Branca, Colla, et al., 2024) in chapter 3.4).

In the 2024 survey, according to the majority of survey participants, energy efficiency and industrial symbiosis play an important role for companies in energy-intensive industries. As Figure 4 shows, 4 out of 5 respondents state that energy efficiency is very important for the company or sector, while this also applies to Industrial Symbiosis for half of the respondents. Only very few respondents (12% for industrial symbiosis, 8 % for energy efficiency) rated these topics as (very) unimportant.

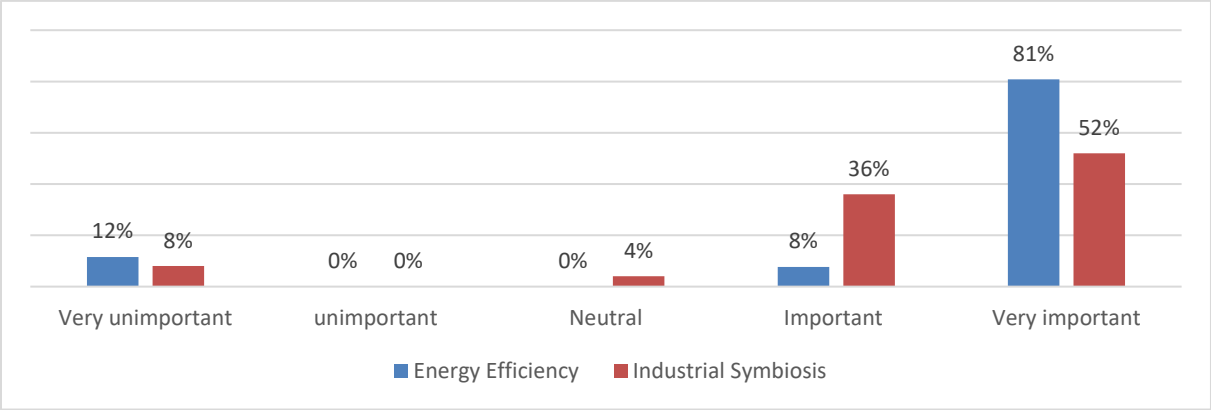


Figure 4: Importance of Energy Efficiency and Industrial Symbiosis for the sectors / companies *(Respondents: n = 27)*

In the second survey 2024 a great majority of the participants considered the need for training for Energy Efficiency and Industrial Symbiosis to be rather large or very large, while only 12% (Industrial Symbiosis) and 4% (Energy Efficiency) expect the challenge to be rather small.

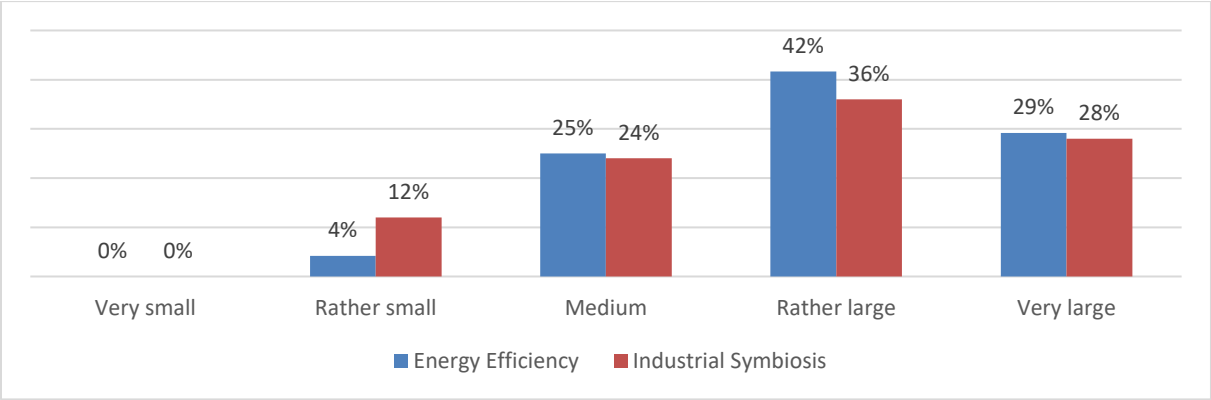


Figure 5: Need for Training *(Respondents: n = 24 for Energy Efficiency, n = 25 for Industrial Symbiosis)*

The *company survey* 2021 across the different sectors (see in detail in D2.1; Branca et al., 2024, pp. 222–238) reflects that the current *level of technological implementation* (focusing mainly on process, digital, by-product quality improvement technologies, the production process chain and specific energy and sustainability departments) is higher for Energy Efficiency rather than for Industrial Symbiosis, although companies perceive both as an important opportunity emphasising their efforts in the future towards these topics. Compared with the implementation level, the *level of skills* is stated to be generally lower for Industrial Symbiosis than for Energy Efficiency (see Figure 6).

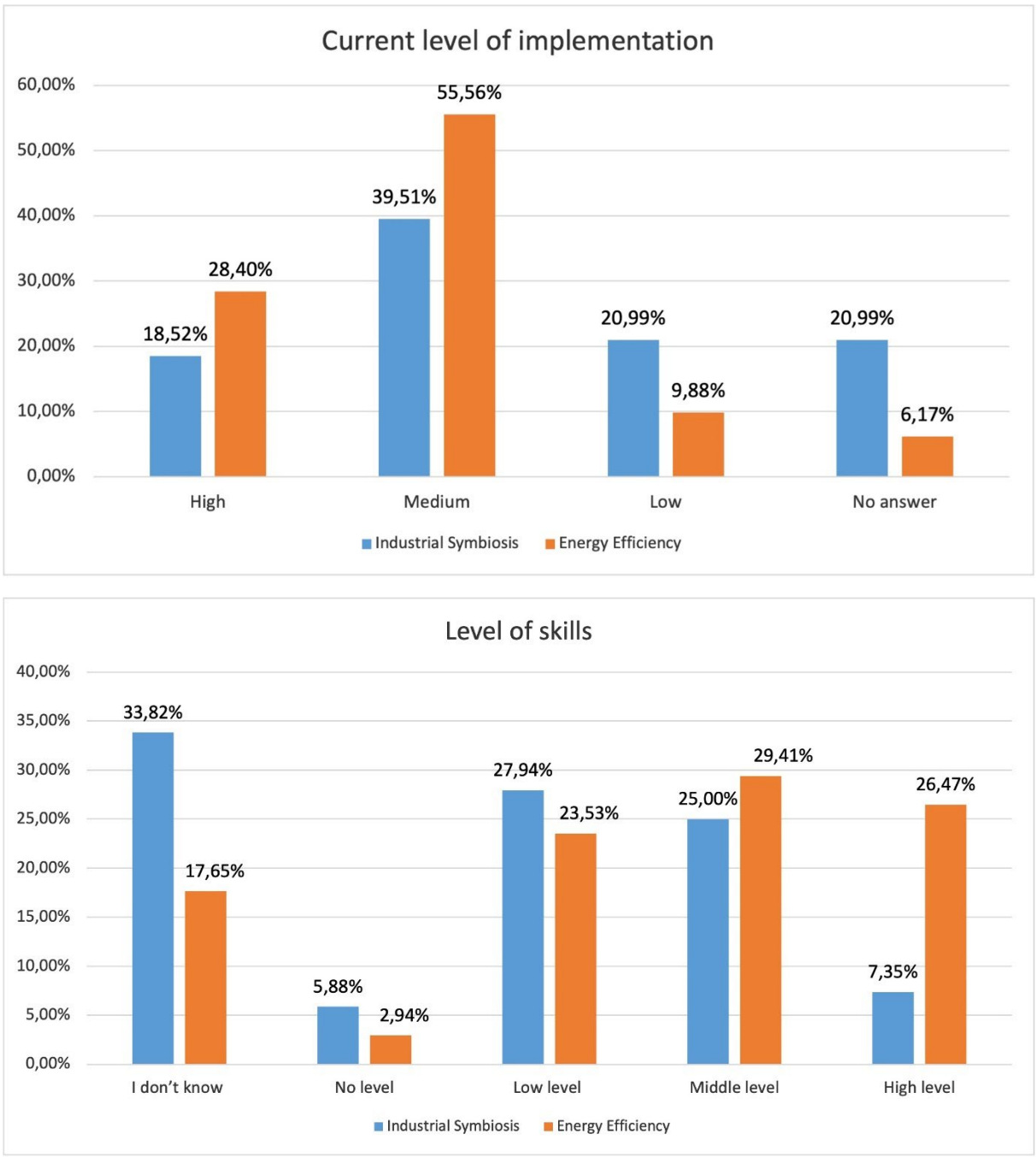


Figure 6: Technological Implementation and Level of Skills

By implementing Industrial Symbiosis and Energy Efficiency, companies expect not only a broad range of economic *benefits* (mainly more efficiency and reduction of costs, increasing sustainability and competitiveness) but also an improvement of green skills and performance of the workforce as well as new jobs and professional figures. *Barriers* are related to implementation practices and perception of solutions and the creation of new skill demands in any category of workers. The main barriers are cost of investments, working across sectors, integrating regional stakeholders, regulatory issues, outdated plants, infrastructure and equipment, cooperation challenges, and skills gaps (see Figure 7).

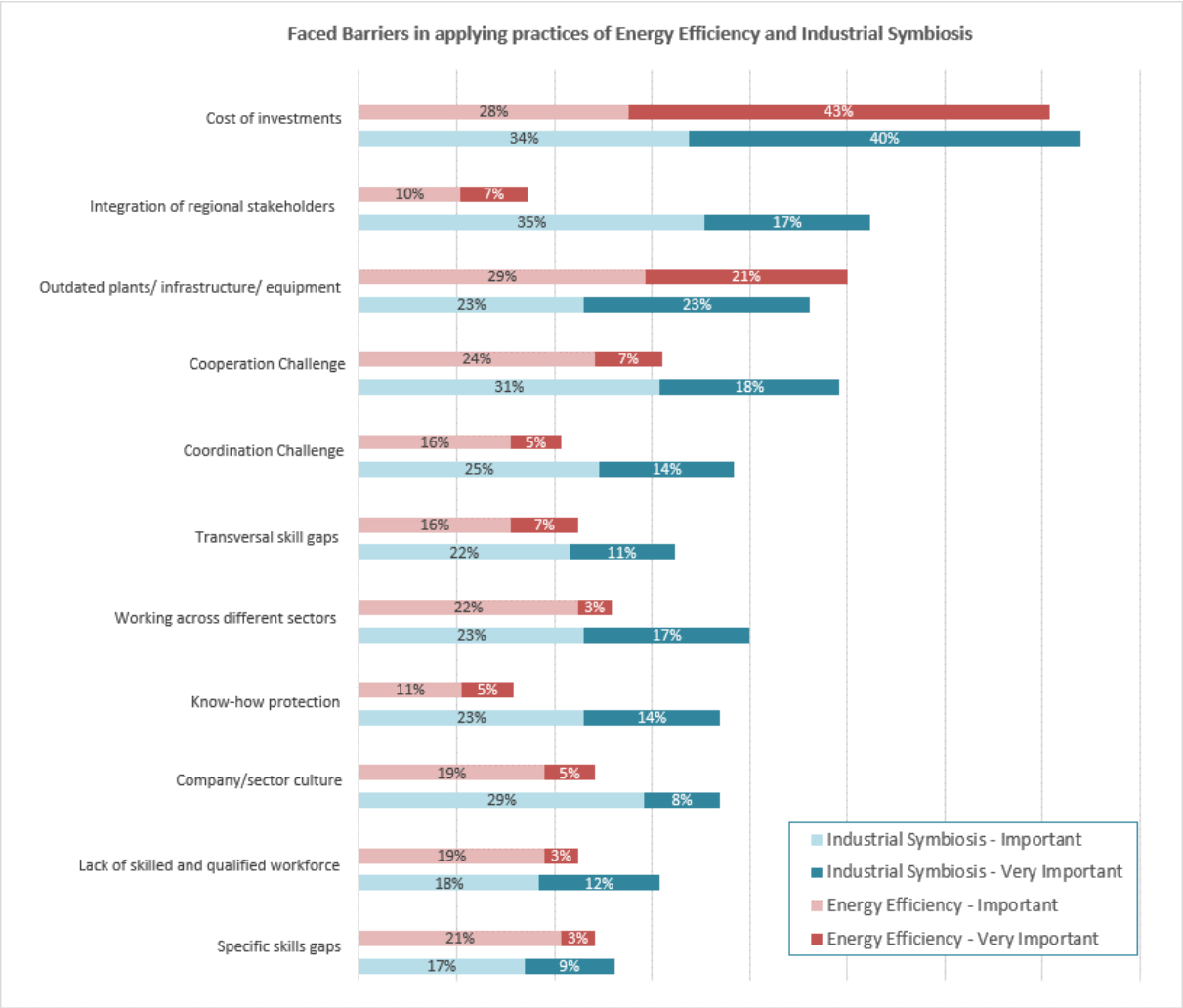


Figure 7: Importance of Barriers Faced for the Implementation of IS and EE *(see detailed figures in the Annex 8.5)*

As skills gaps are a (very) important barrier for about one third of the respondents, the current *training measures* implemented by companies are mostly not formal and unstructured. Emerging and future skill gaps will be overcome by internal and external training (see Figure 8). While a higher workforce performance is needed in both areas (EE and IS), the almost incremental upskilling is complemented by new jobs or professions especially in IS. The skills that are most needed to be updated in the incoming 3 to 5 years are identified in specific job-related skills, digital and personal skills. Other useful skills identified within the survey are regulatory and entrepreneurial skills. In particular low and middle level skills need to be updated.

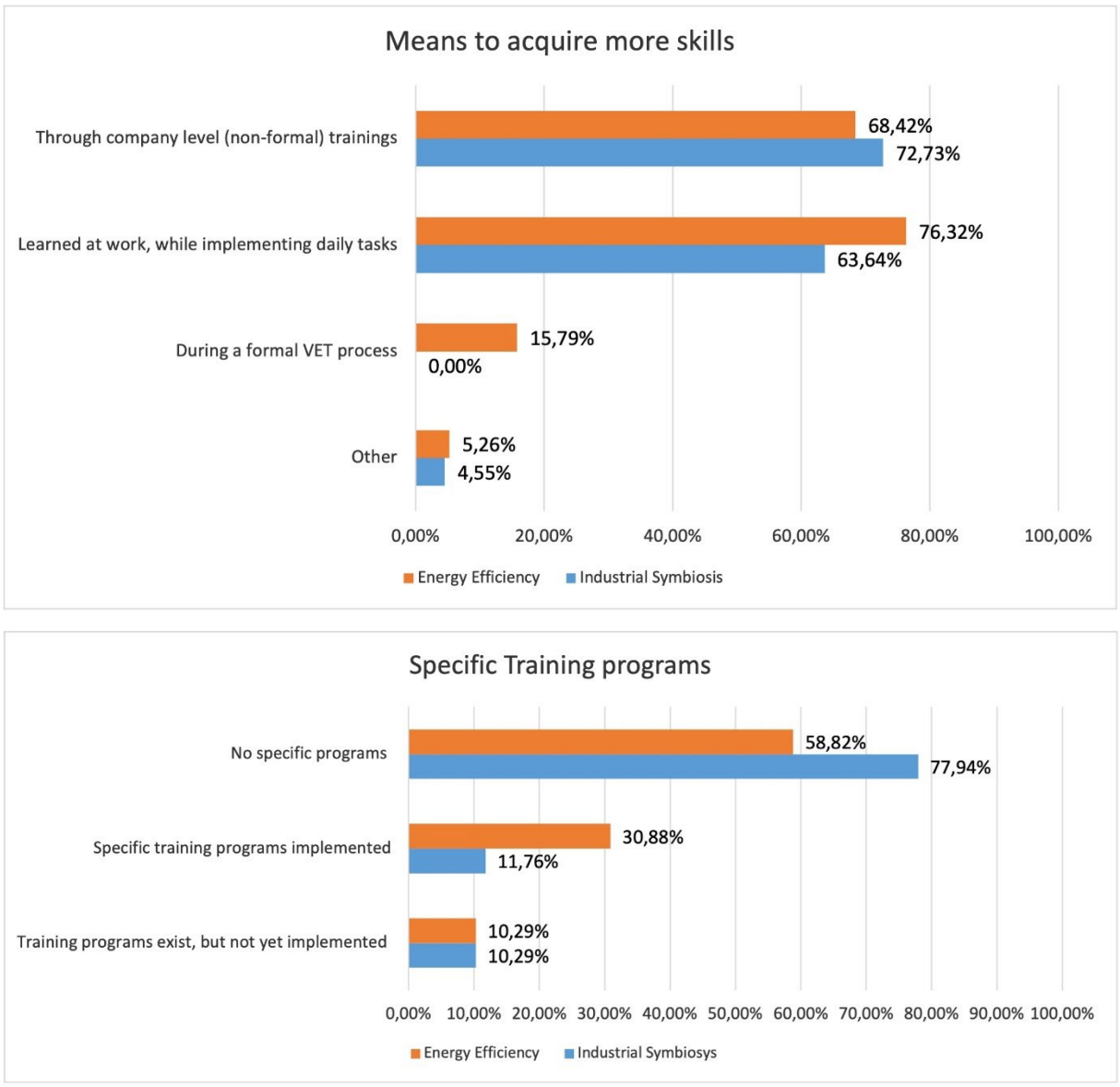


Figure 8: Skill Improvement Strategies

The participants were 2024 also asked regarding the current and future composition of the workforce. According to their answers, the percentage of highly and medium skilled employees will increase by 6 and 3 percentage points respectively, while the percentage of low-skilled employees will decrease - this expectation corresponds to the idea of an upgrading process of the workforce (cf. Eurofound, 2015; Hirsch-Kreinsen, 2016).

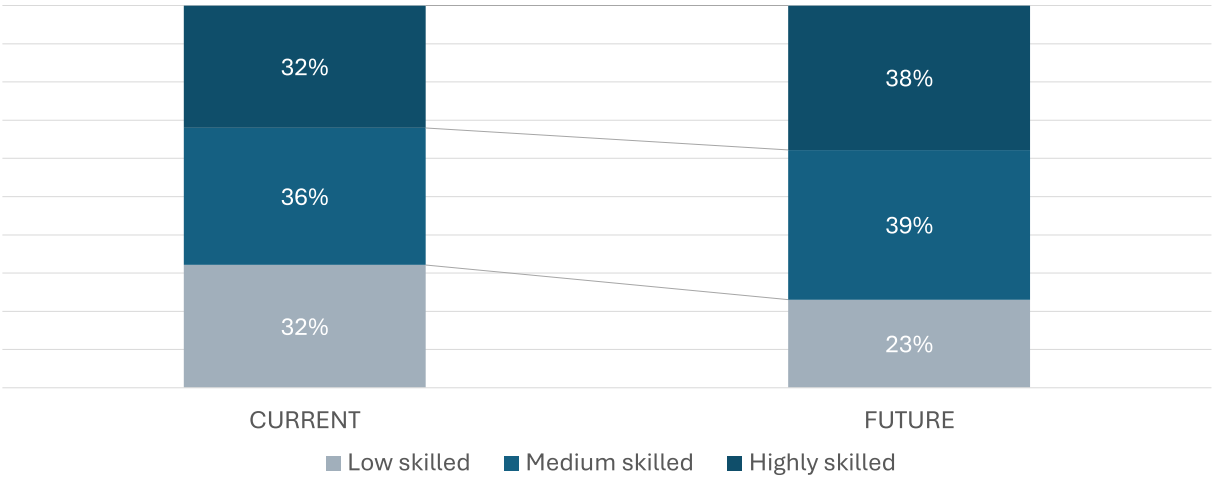


Figure 9: Current and future composition of workforce *(Respondents: n = 24 (Current Composition), n = 25 (Future Composition)*

The survey in 2021 already pointed out that the companies are mainly focusing on upskilling, due to the fact that it is hard for them to get talents from the labour market. As shown in Figure 10 changing company structures by filling in new positions is highly difficult for the companies. Only one respondent stated that filling vacancies was easy, while around 3 out of 4 respondents rated the challenge of filling vacancies as difficult or even very difficult.

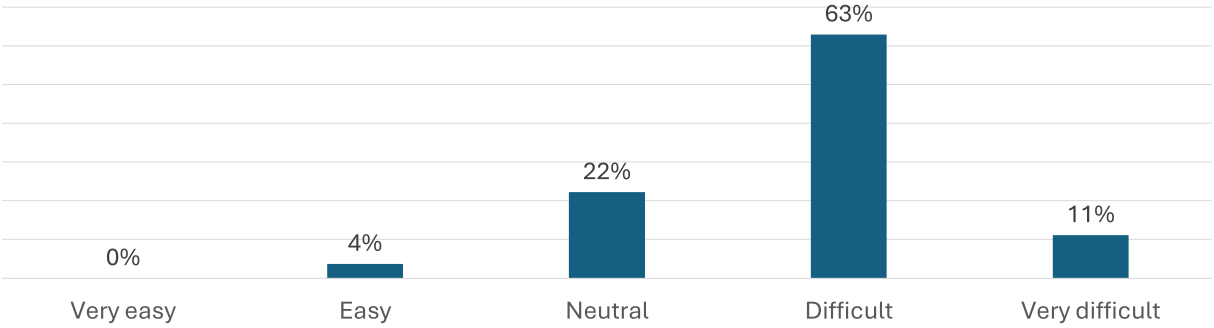


Figure 10: Difficulty to fill vacancies *(27 respondents)*

2.1.4 Summary

To summarise the results of the technological, economic and related skills review the Blueprint focuses on:

- Extending the 4R approach to the 5R concept by adding "re-education": Reduce, Reuse, Recycle, Restore, and *Re-educate* (as done in the project 5REFRACT)
- Incremental and complementary *upskilling of existing occupations and job profiles* (see Figure 11), but taking also into account *additional new job profiles* (such as the IS Facilitator)
- Distinction between skills for Energy Efficiency (lower level demand) and for Industrial Symbiosis (higher level demand)
- Managerial (business and regulatory) and operational skills (technical, transversal/individual).

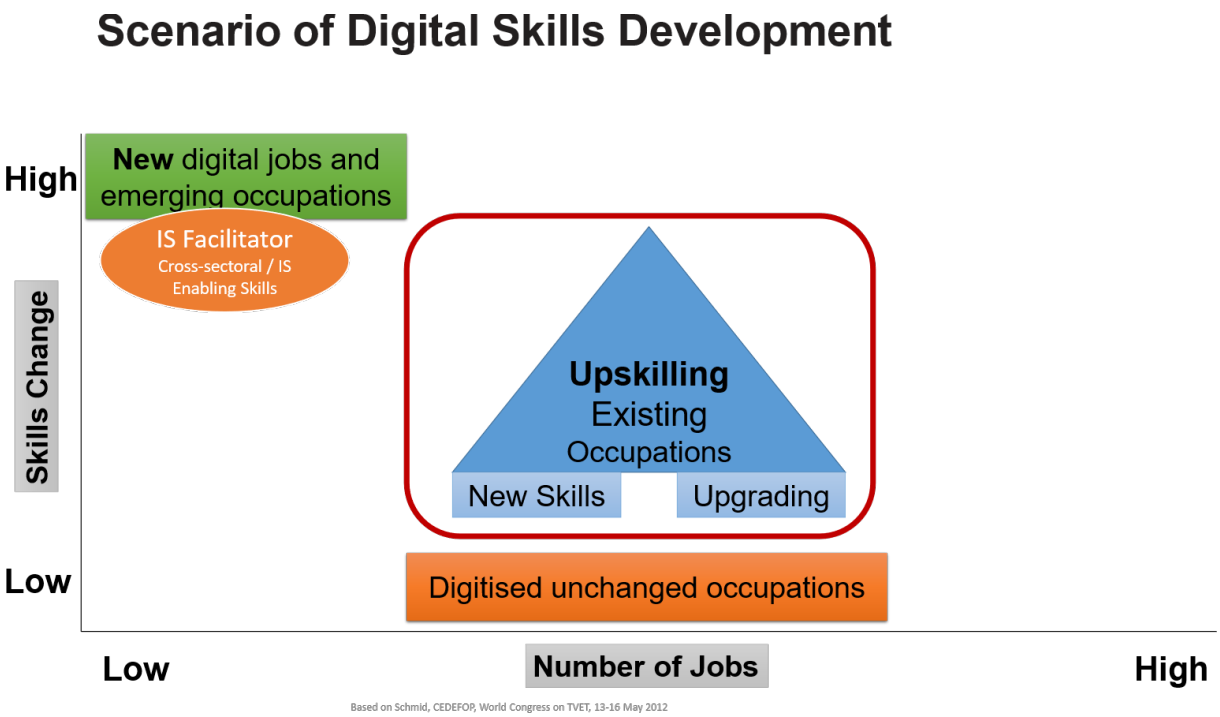


Figure 11: Complementing and Upskilling of Existing Occupations within the Focus of SPIRE-SAIS

Due to the higher number of affected existing job functions and occupations, SPIRE-SAIS is focusing on incremental skills adjustments, expecting a middle change of existing skills and a middle up to high number of jobs. Additionally, there will be a few new job profiles or occupations such as the Industrial Symbiosis Facilitator (already in focus of a training program developed by the INSIGHT project). Being created for cross-company coordination, the IS Facilitator job nevertheless might also become part of a company internal job function (on the management level).

2.2 *Skills Adjustment Approaches*

Future changes in the professional skills requirements of the industries, the context of increasing environmental constraints and energy costs and possible incorporation into VET and tertiary education training curricula were considered.

The following methodological steps were conducted to examine the range of essential skills, knowledge and experience that workers require to adopt Energy Efficiency and Industrial Symbiosis in daily work in the different industry sectors:

1. Literature review
2. Summarising the main *facts and figures of the sectors* (subsectors, direct jobs, production, energy, waste, and Industrial Symbiosis) as a background information (see Annex 8.4)
3. Creation of *organisational flow charts* in different sectors selecting job profiles related to Industrial Symbiosis (see Annex 8.6)
4. Grouping similar *sectorial job profiles* and finding equivalencies with occupations of the ESCO database and ISCO groups
5. Identification of related skills and grouping them to a specific sector overarching *skills classification*

6. Job profile related skills *assessment* (skills gaps, current and future proficiency levels)
7. Job profile database improvement (connected with ESCO/ISCO occupations and the related VET occupations).

As the literature review summarised in Deliverable D3.2 (Bayón, 2024) and the Fact and Figures (added in Annex 8.4) form the basis for the analysis of industry requirements, the following focuses on the main elements for the Blueprint development: learning outcomes methodology, organisational flow charts of the sectors leading to the job profile identification and selection, and the related skills classification. Other key methodological elements are functions, skills mapping, integration of the qualification perspective, learning solution and skills gap assessment.

2.2.1 Learning Outcome Pipeline Methodology

The Learning Outcome Pipeline methodology is a systematic approach designed to create a coherent and structured link between industry requirements with educational institutions.

- **Organisational Flow Chart:** We start by analysing Organisational Flow Charts to identify those occupations that need to be developed or updated and then creating a standard Organisation Flow Chart to help organise the information.
- **Job Profiles and Occupations:** The starting point is to identify specific job profiles and occupations. These are defined functions and roles in the company and job market with particular responsibilities and expectations, which are connected with technological innovation, changes in regulations, digitalization among others.
- **Functions:** For each job profile or occupation, we outline the primary functions or duties that the role entails. This helps to break down the occupation into manageable tasks and responsibilities. The ESCO platform offers a set of tasks for occupations to be used as a baseline.
- **Skills:** From these functions, we identify the essential skills required to perform these tasks effectively. Skills can be technical, interpersonal, cognitive abilities among others that are necessary for job performance.
- **Learning Outcomes:** Based on the skills identified, we develop specific learning outcomes. These are clear, measurable statements of what learners should know, understand, or be able to do after completing a learning activity. The categorizations and the format of those are writing should be in line with guideline of Cedefop (2017).
- **Qualifications:** Learning outcomes are then mapped to formal qualifications. This ensures that the education and training provided meet the requirements defined in the project.
- **Training Resources:** Finally, appropriate training resources are selected or developed to achieve the learning outcomes. These resources include courses, workshops, online modules, textbooks, and practical training sessions, among others.
- **Skill Gap Analysis:** Identification of the difference between the skills required for an occupation and the skills currently held by employees, enabling organisations to pinpoint training needs, improve employee performance, enhance productivity, and ensure alignment with business goals and market demands.

By following this methodology, we ensure that there is a clear, logical progression from the requirements of a particular occupation to the specific training resources needed to prepare individuals for that role. This approach helps in creating a well-aligned and effective educational pathway that meets the needs of both learners and employers.

2.2.2 Organizational Flow Chart

Considering the future technological developments for the implementation of IS and EE solutions within process industry summarized above and skills development concepts stated in other recent sources (reports like Steel Sector Careers (White Research et al., 2019), McKinsey study (Bughin et al., 2018), the portfolio review of the projects on Industrial Symbiosis by the European Commission (Sommer, 2020), several book chapters and scientific articles (see D3.2; Bayón, 2024), new skills and training needs within the energy intensive sectors were explored. Focusing on near Organisational Flow Charts

After summarising the main facts and figures of the involved sectors, job profiles related to IS and EE or both (including both intermediate management levels and blue-collar profiles) were identified by elaborating organizational flow charts of most of the sectors involved: cement, ceramics, chemicals, minerals, steel, and water. Figure 12 below is illustrating step by step the procedure applied in the ceramic sector as an example.

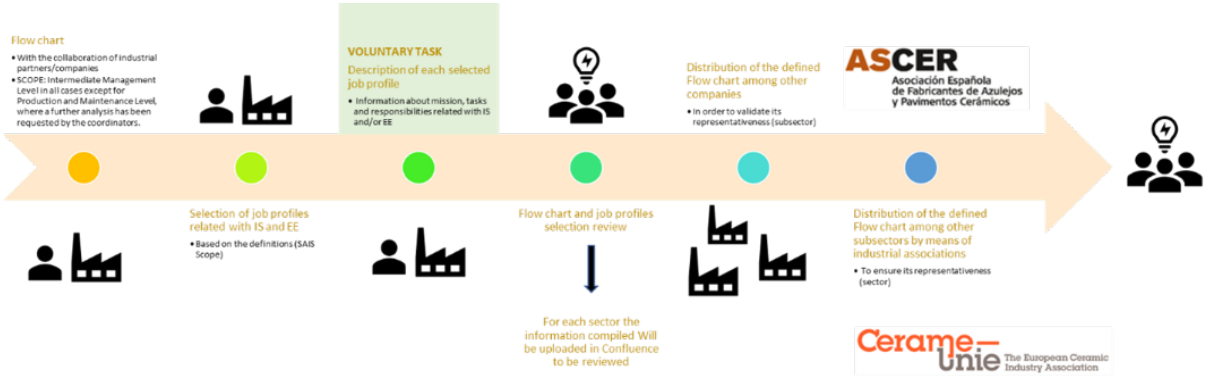


Figure 12: Development Process of sectoral Organisational Flow Charts and Job Profile Selection

Based on this process Organisational Flow Charts of the main sectors were established showing the EE and IS related job positions (see the flow charts of each involved sector in the Annex 8.6). While e.g. in the cement sector each selected job profile is related to both EE and IS, in the example of the steel sector there are job profiles dedicated to just Industrial Symbiosis or Energy Efficiency or to both. Further distinction is made between the job profiles in the production on the one hand and in a series of functional areas (materials/products, maintenance, logistics, purchase, and others) on the other hand.

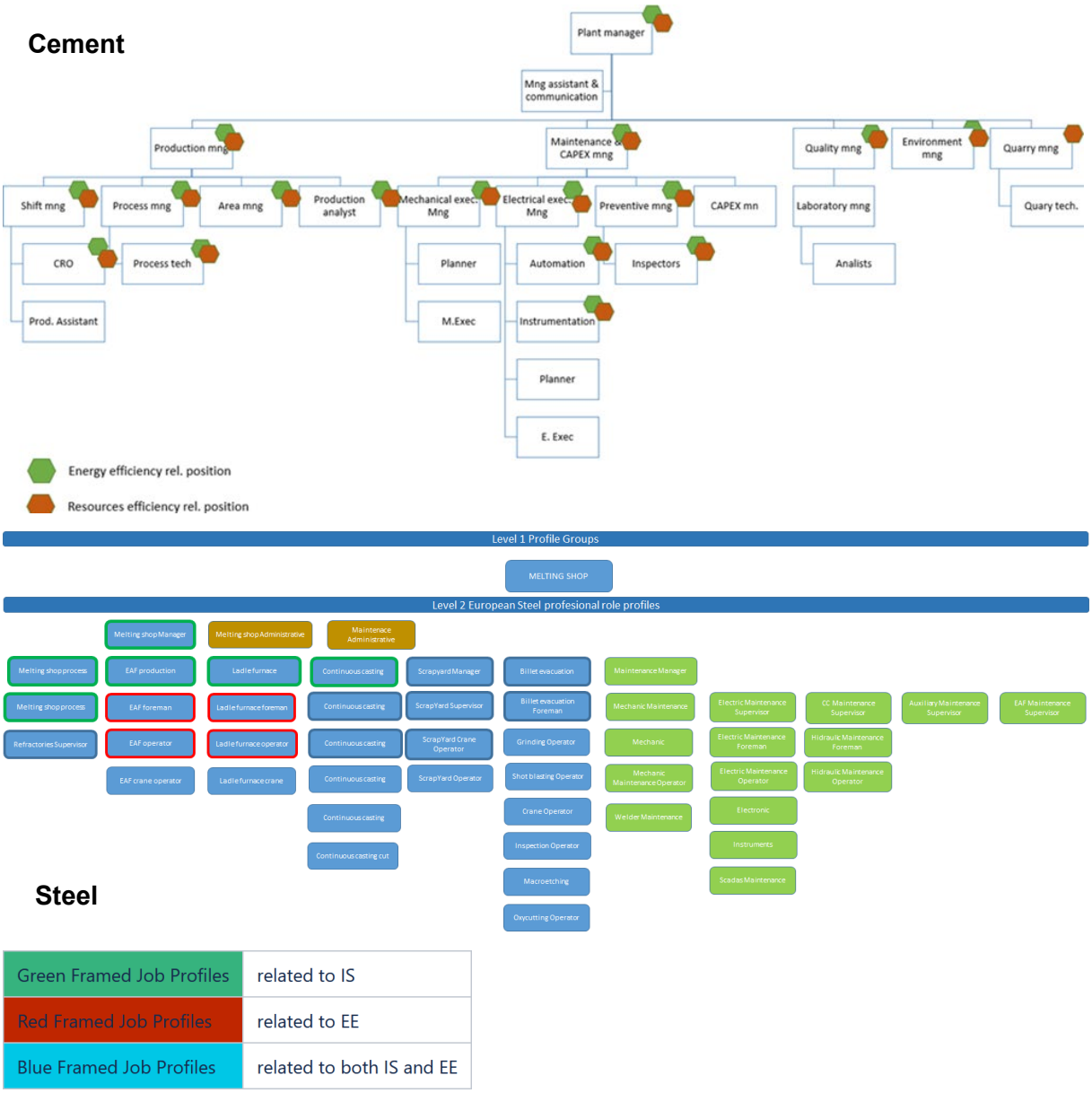


Figure 13: Organisational Flowcharts (Examples Steel and Cement)

Based on this process carried out by the companies involved in SPIRE-SAIS, we obtained huge list of job profiles in the different sectors. To reduce complexity, they were grouped in sectoral overarching main job profiles, which were accepted as a common basis for identifying related skills.

2.2.3 Identification and Selection of Job Profiles and Occupations

Based on a literature review, facts and figures datasheets, organisational flow charts and job profile and skills selection of the different sectors were done by the involved companies and reflected by the consortium, especially with the sector associations. As it was not so easy to find a common overarching description of the organisational flow charts in each sector (because each company has its own specifications and production areas, products) it was also challenging to agree on an overarching selection of similar job profiles across all sector. Reflecting the results of the technological development, concentrating on the highest common denominator and reducing complexity to a manageable list, sector overarching job profiles affected by Industrial Symbiosis and Energy Efficiency were selected (see Figure 14). Therefore,

the Blueprint is based on cross-sectoral generic job profiles of production and functional areas, each represented by a managerial and operational function:

- Production areas and functional areas (management of materials/products, energy, environment, waste, maintenance, purchase, logistic, legal/regulatory, human resources, and quality)
- Management and operational level (aligned to the production and functional areas)
- A new cross-company Industrial Symbiosis Facilitator job profile focusing on the enabling IS function.

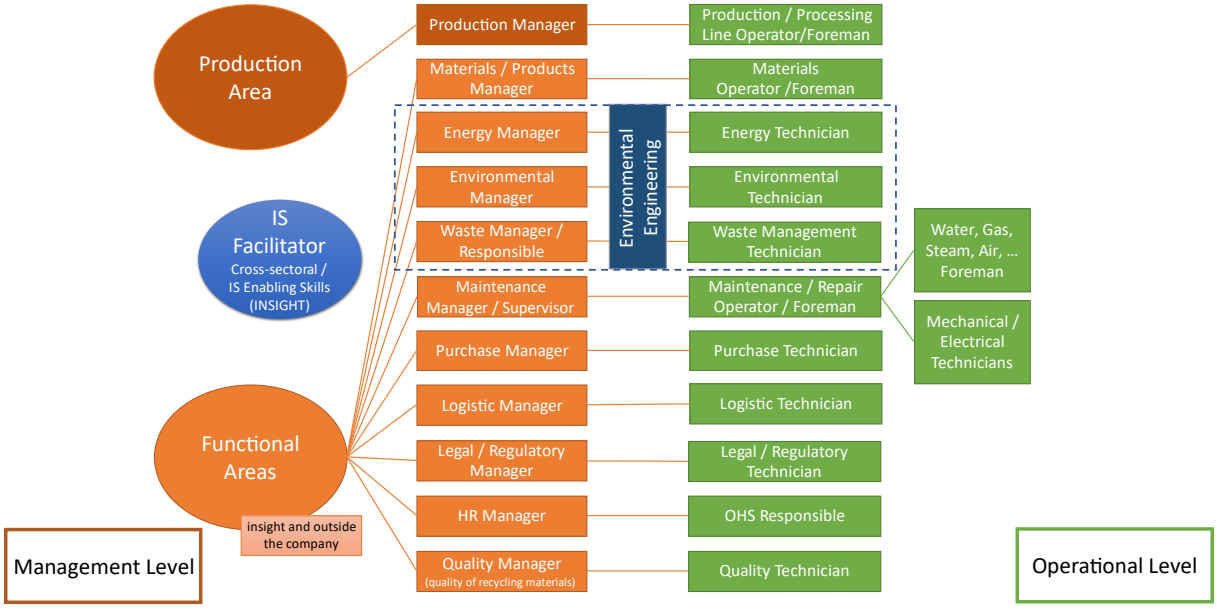


Figure 14: Cross-sectoral Generic Job Profiles and Function for EE and IS

Comprising production and functional areas, each area is represented by the related manager function (management level) and the dedicated operators/foremen/technicians (operational level). All these job profiles have company internal functions but could also become part of an Industrial Symbiosis cooperation across sectors and companies. As it is evident that managerial skills and operational skills are different (at least concerning the concrete tasks and the level of skills), both management skills and operator or vocational skills are coming into focus. In the course of the improvement further pooling lead to combine the Energy Manager, Environmental Manager and Waste Manager in a common profile "Environmental Engineering" including those three job functions just as specific parts.

In a survey conducted 2024 we asked which manager and operator job profiles were known to the respondents from their everyday work, whether in a company or in another organisation with a connection to energy-intensive industries. With regard to the manager profiles (see Figure 15), the Production Manager (81%) and the Materials / Product Manager (78%) were the best known profiles, followed by the HR Manager (74%) and the Quality and Maintenance Manager (70% each). The least known profile was the Waste Manager / Responsible with around one in two participants who knew the profile from their everyday work.

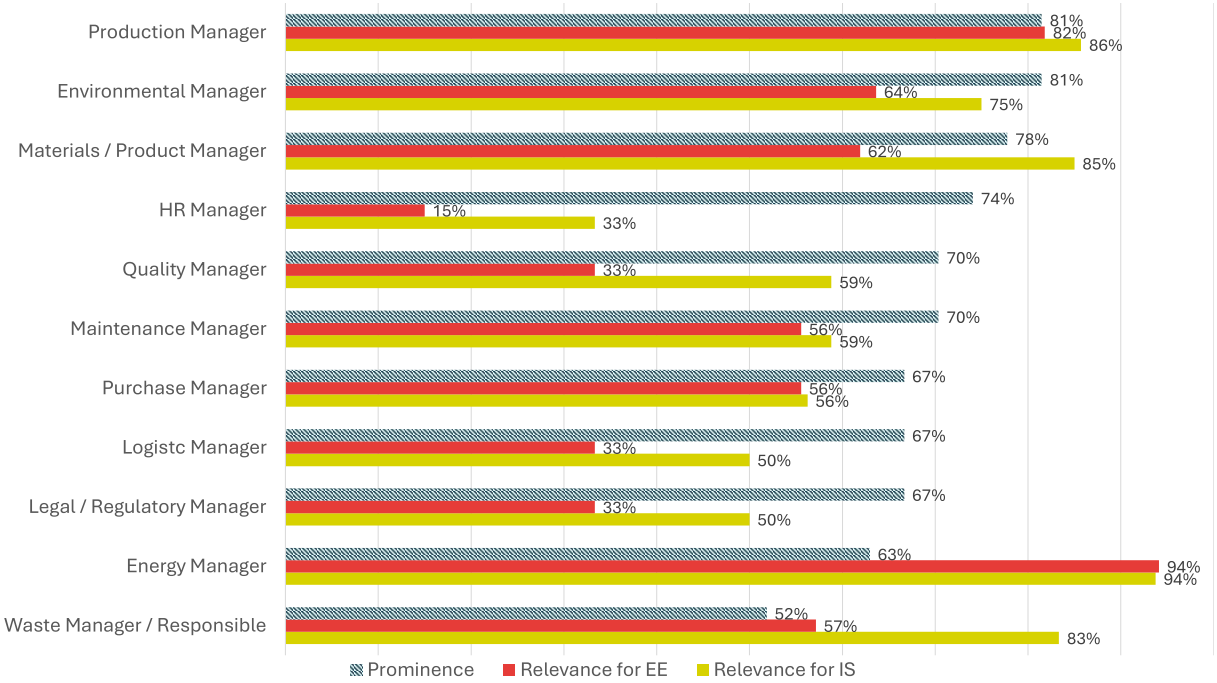


Figure 15: Prominence of manager profiles, *% of participants who know the profiles from their daily work & their importance for EE and IS (% of par-ticipants who selected the upper two points in a 5-level scale). Respondents: n=27 (Prominence), n=14 to 22 (relevance to Energy Efficiency), n=12 to 21 (relevance to Industrial Symbiosis)*

For the operator profiles (see Figure 16), the Production / Processing Line Operator / Foreman Materials, the Maintenance / Repair Operator / Foreman and the Materials Operator / Foreman were in the foreground with 78 to 81 percent knowledge ratio for each profile (see Figure 16). Similar to the managers, the Waste Management Technician was the least recognised profile among the operator profiles.

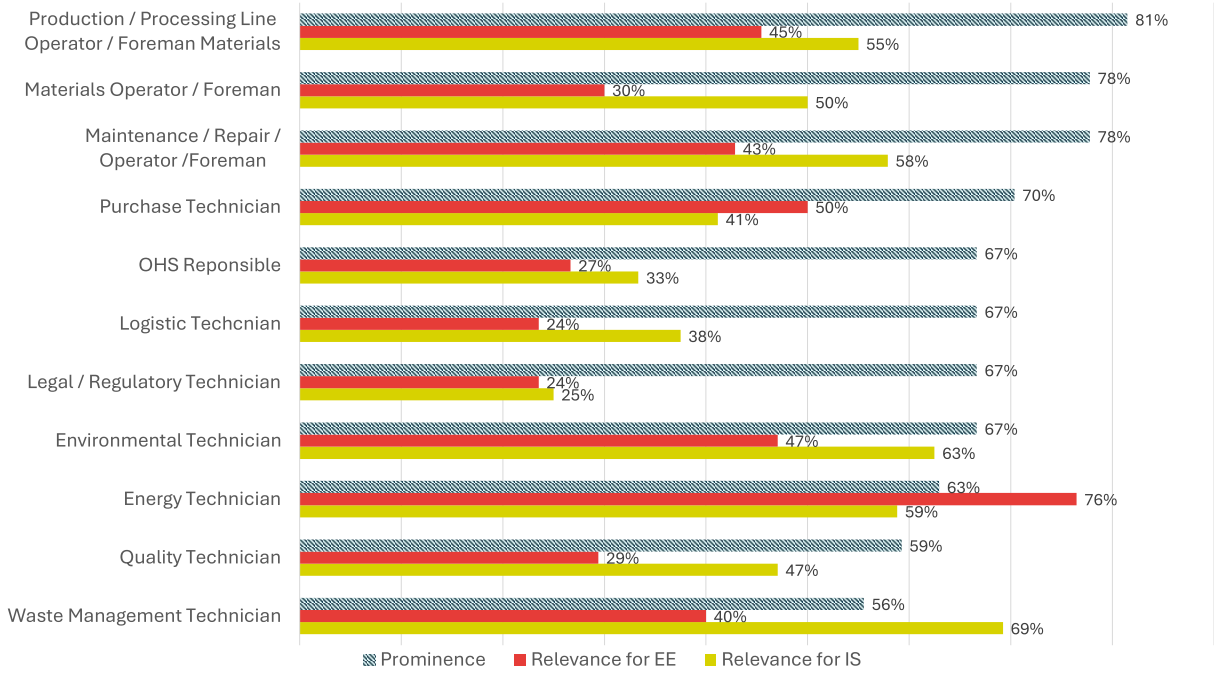


Figure 16: Prominence of operator profiles, *(% of participants who know the profiles from their daily work) & their importance for EE and IS (% of participants who selected the upper two*

points in a 5-level scale), Respondents: n=27 (Prominence), n=15 to 22 (relevance to Energy Efficiency), n=13 to 20 (relevance to Industrial Symbiosis)

55% of participants took the opportunity to name other relevant profiles, that were not present in the survey. The following profiles were named (standardised spelling):

- Energy transition manager
- Chemical process technicians and engineers
- Careers in the paper industry
- Financial manager
- Processing engineers
- Due diligence manager
- Chief sustainability officer
- Continuous improvement professional (manager and technicians)
- R&D functions
- Innovation manager
- Automation developers
- Process engineers who follow daily the assets consumptions and propose and implement actions to improve the consumptions
- Energy consumptions manager
- Wood management
- Sales manager
- Warehouse operators
- Sustainability leader
- Maintenance
- Paper recycling
- Social relations manager
- Laboratory technicians
- Supply chain
- Agriculture (metanisation, etc.)
- Technical manager
- R&D experts
- Shop steward

As already the selected and agreed job profiles of SPIRE-SAIS show, Energy Efficiency and Industrial Symbiosis are affecting a broad range of job profiles. The named profiles cover a wide range of additional areas, from sector-specific profiles (Wood Management, Agriculture) to overarching professional profiles (Financial Manager, Sales Manager), as well as profiles related to energy and sustainability (Energy Transition Manager, Energy Consumption Manager, Sustainability Leader).

As also shown in Figure 15 and Figure 16, the importance of the job profiles for Energy Efficiency and Industrial Symbiosis was captured as well, if the profile was known to the participants. Thereby some insights stand out:

- On average, the operator profiles receive slightly lower average scores in terms of their relevance for Energy Efficiency and Industrial Symbiosis
- The Energy Manager and Energy Technician profiles stand out, both of which have a high relevance for Industrial Symbiosis and Energy Efficiency – e.g. 94% of participants rated the Energy Manager with 4 and 5 on the 5-level scale (hereinafter referred to as importance ratio)
- Similarly, the importance ratios of the Waste Manager and Waste Technician, Production Manager, Environmental Manager and Materials / Product Manager profiles is relatively high compared to their general prominence to the participants
- Overall, the most important profiles in terms of Energy Efficiency are Energy Manager (94%), Production Manager (82%) and Energy Technician (76%), while Energy Manager (94%), Production Manager (86%) and Materials and Product Manager (85%) are in the lead in terms of Industrial Symbiosis

- Profiles such as Human Resources Manager or Legal / Regulatory technician are only of minor importance for Industrial Symbiosis and Energy Efficiency (15 % / 33 % respectively 24 % / 25 % importance ratio).

Based on the technological foresight (see Section 2.1), the selected job profiles are focusing mainly on an incremental upskilling or complementation of existing skills. But recently, there is at least one important additional professional job profile: The Industrial Symbiosis Facilitator. With reference to the INSIGHT project, the Industrial Symbiosis Facilitator's tasks are analysing IS possibilities in a defined area or region, defining and promoting possible synergies between companies from different sectors, capitalising benefits, and others. As this job profile with needed skills and a related training program is already developed by the INSIGHT project, SPIRE-SAIS integrated it in the SKILLS4Planet online training platform ensuring its continuous running after the project life span. Looking at the curriculum of the training course for the IS Facilitator (see Figure 17), management and transversal skills similar to the SAIS ones could be identified, but focusing evidently on the cross-company cooperation perspective which are perfectly in line with the company and cross-sector related SPIRE-SAIS approach. *The IS Facilitator therefore is the missing link between the company's skills improvement and the common cooperation on Industrial Symbiosis*, mutually improving IS facilitating skills for cooperation, overall and company internal management of IS and EE.

Figure 17: IS Facilitator Curriculum (Insight, 2020, p. 8)

The following occupations identified by SPIRE-SAIS can be found already in SKILLS4Planet[1] (see Figure below).

[1] https://hub.skills4planet.eu/competencemap/occupations/search?search=

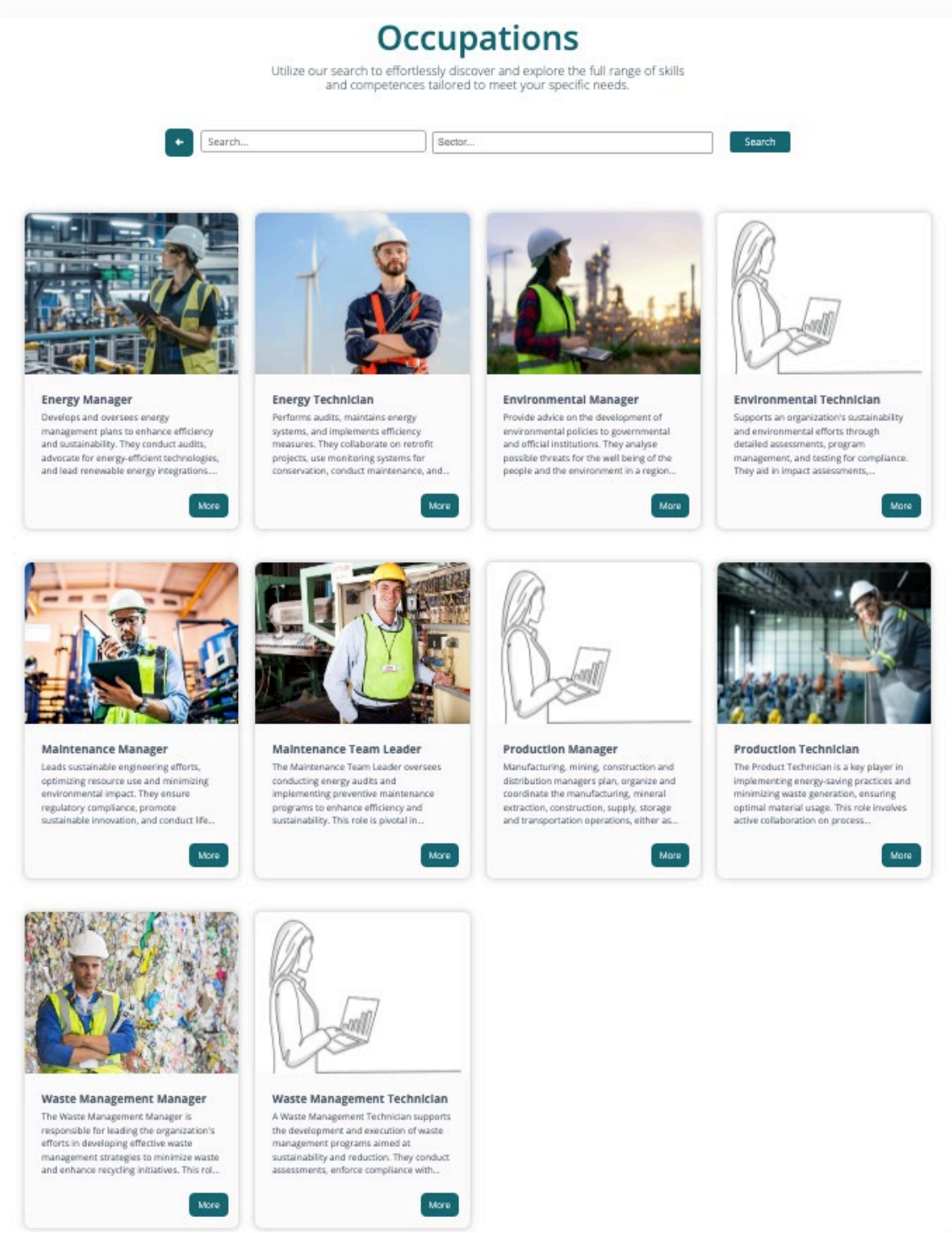


Figure 18: Occupations Directory

2.2.4 Functions

Function analysis aims to identify the specific skills and competencies required for a particular job role. The objective is to systematically break down the tasks associated with the job and identify the essential abilities and knowledge needed to perform for effective those tasks effectively.

The process begins with identifying all tasks involved in the job, followed by detailed task analysis to understand the steps and requirements of each task. The tasks are used in ESCO and

several other standards to define occupations, such as the Occupation 1349-12 Energy Manager[2]. The following image shows the tasks for this occupation

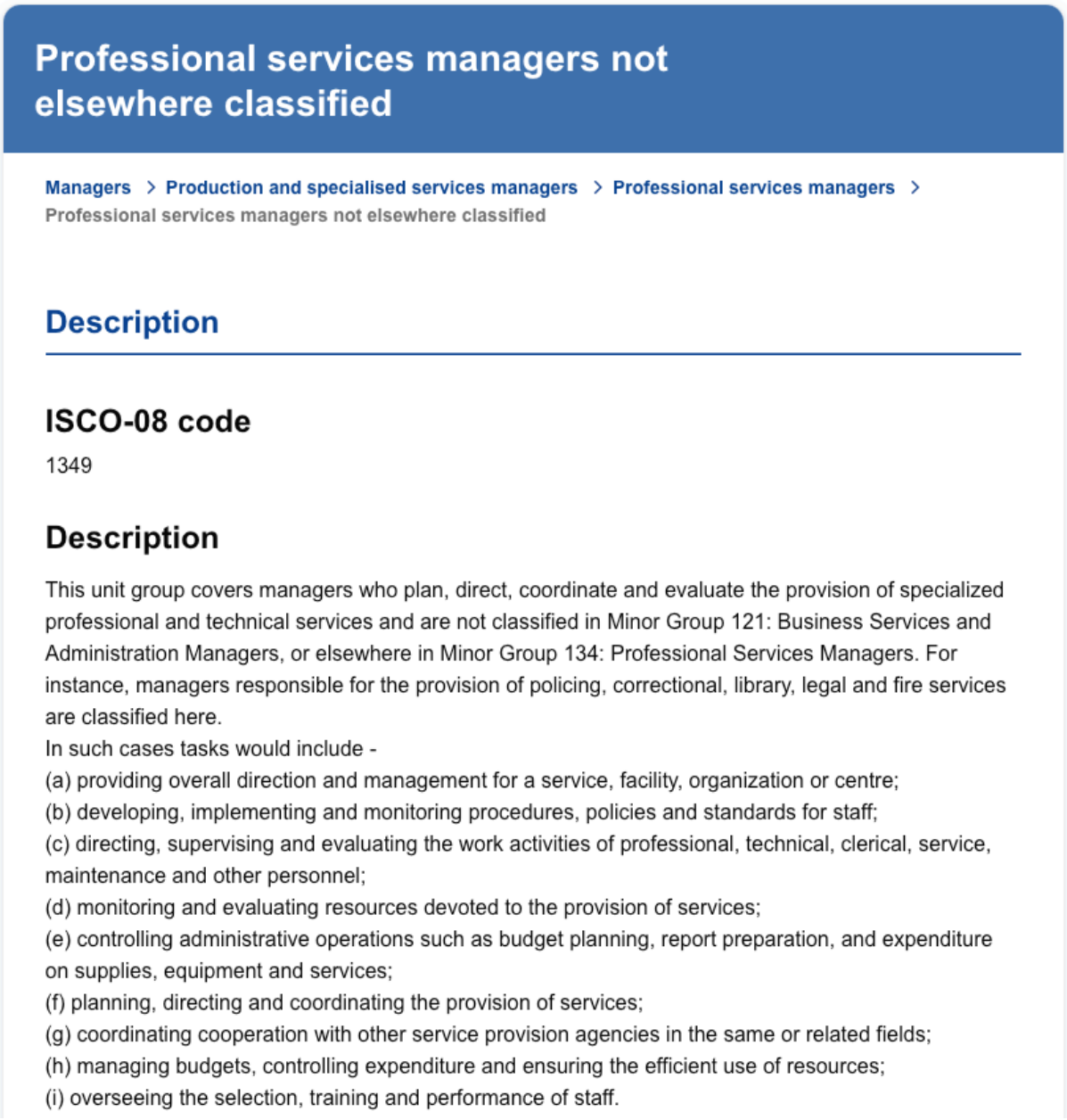


Figure 19: Occupation defined in terms of Task in ESCO

Defining job positions related to Industrial Symbiosis and Energy Efficiency through tasks aligns closely with the concept of work instructions, which are detailed guidelines outlining specific steps and procedures for carrying out in the industrial processes. By breaking down job roles into manageable tasks, organizations can streamline the identification of key responsibilities and requirements. This approach facilitates a common understanding among stakeholders. Clear and standardized task definitions promote operational efficiency, enhance collaboration, and ensure that all parties adhere to agreed-upon practices and goals. Work instructions derived from these defined tasks serve as invaluable tools for employees, guiding

[2] https://esco.ec.europa.eu/en/classification/occupation?uri=http%3A%2F%2Fdata.europa.eu%2Fesco%2Foccupation%2Fa005f8a2-2d8a-433e-8d89-13575f822fd4#overlayspin

them in executing their duties effectively to achieve optimal Industrial Symbiosis and Energy Efficiency outcomes.

Once the skills have been identified and prioritized based on their importance to the job role and task, stakeholder input and validation ensure accuracy, culminating in the creation of a clear job profile outlining the skills required for recruitment, training, and performance evaluation purposes within the industry.

2.2.5 Skills Mapping

In parallel and attuned with the selected job profiles and occupations, a first selection and mapping of skills needs and competences was conducted. Beside the literature review results, the collection of needed skills was done by the involved companies, leading to a matrix of 65 different skills across the involved sectors. The skills were ranked in order of importance and reduced to at least a manageable set of skills topics/families/groups (see Figure 20). As already stated, technical/technological and individual skills are in place for the management and operational area; additionally, the management level is focusing on business and regulatory related skills. These four skill categories do have several related skill classifications, which only differ in the technical/technological category between IS and EE. Individual and personal skills are transversal skills needed by managers but also by operators and technicians. Managerial regulatory and business skills are needed for EE and IS within the company but also for the cross-company Industrial Symbiosis cooperation. In general, it can be said, that the T-shape approach of technological/technical (IS and EE related) and transversal (individual/personal soft skills) is broadened by business and regulatory related skills on the management level. The subjects or topics to which skills will be associated to are listed in Figure 20.

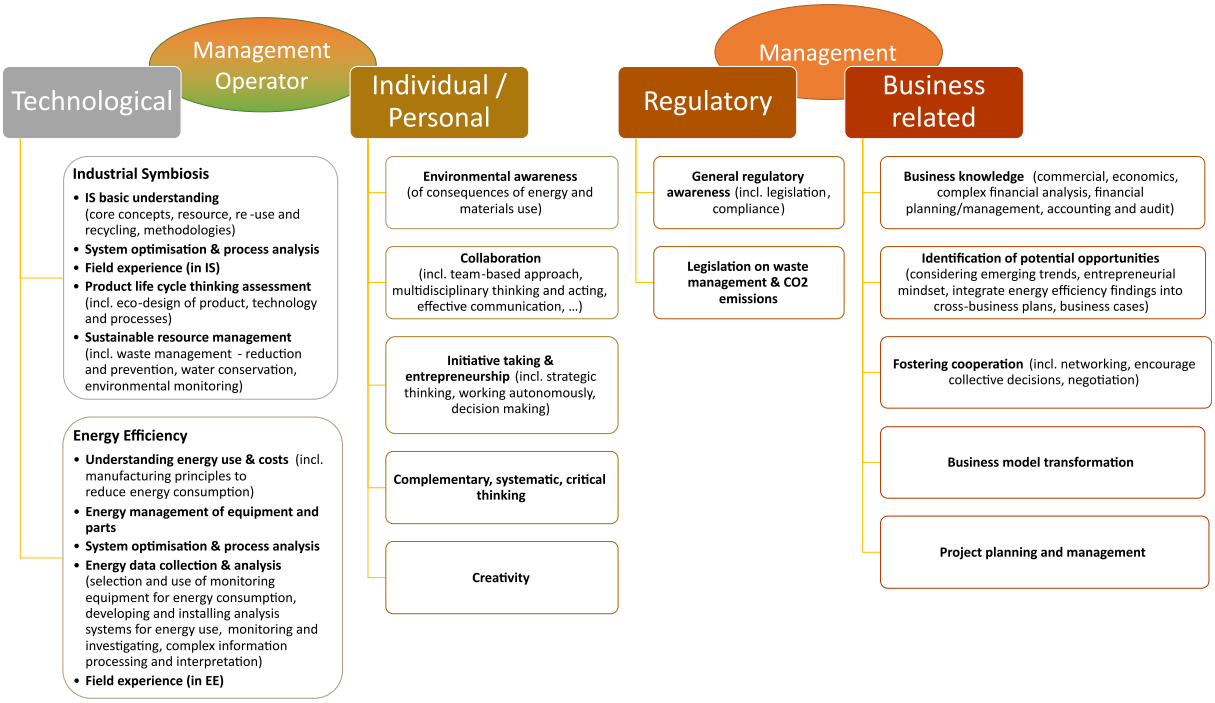


Figure 20: Skills Classification

The skill requirements were captured using skill categories as well as skill levels[3] developed within the SPIRE-SAIS project (see D3.2; Bayón, 2024). Thereby, each broad skill category is composed out of several skill sub-categories.

In our survey 2024, for each sub-category the current and the future skill level was identified for the most important manager and the most important operator profile. The results were interpreted metrically on a scale from 0 to 4. The results for each sub-category were added together for the main categories. For this section, only the overall scores are shown.

When looking at the development of skill requirements for manager and operator profiles (see Figure 21 and Figure 22), it is noticeable that the range of skill levels required is currently at a relatively similar level: 2.6 to 2.9 for manager profiles and a bit lower with 1.8 to 2.0 for operator profiles. In the future not only higher skill levels will be required overall, but also a higher range with higher differences is diagnosed by the participants (2.8 to 3.3 for manager profiles, 2.2 to 2.7 for operator profiles).

This is due to the fact that different degrees of change are expected in the different skill categories. An at least moderate change in skills requirements is expected in particular for functional skills (for energy efficiency and for industrial symbiosis). However, functional skills for energy efficiency are not accompanied by a substantially higher general skill level, at least in the manager profiles. Sustainability skills are also rising in importance and will be in greater demand in the future. At the same time, the other skill categories (social skills (for the manager profiles), personal skills, methodological skills (for both the manager and the operator profiles)) appear to be characterised by a slightly smaller expected increase.

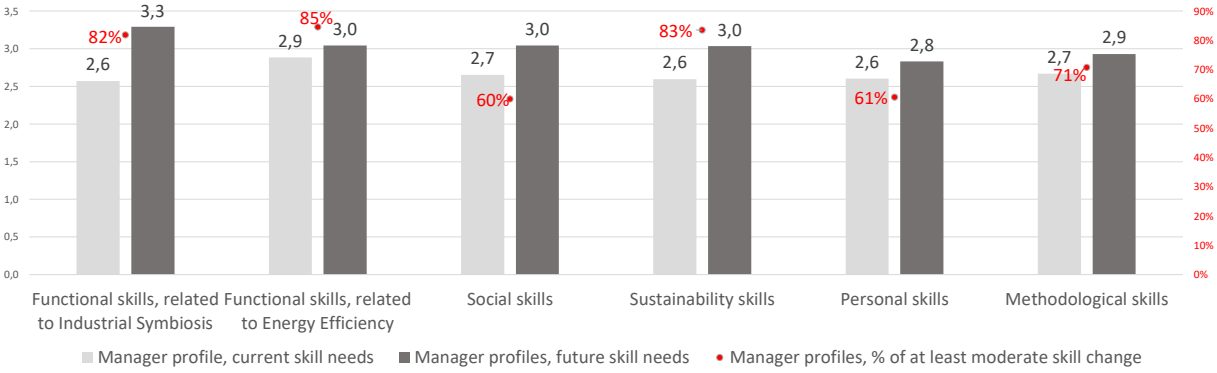


Figure 21: Development of manager profile skill needs *(Respondents: n = 24-26)*

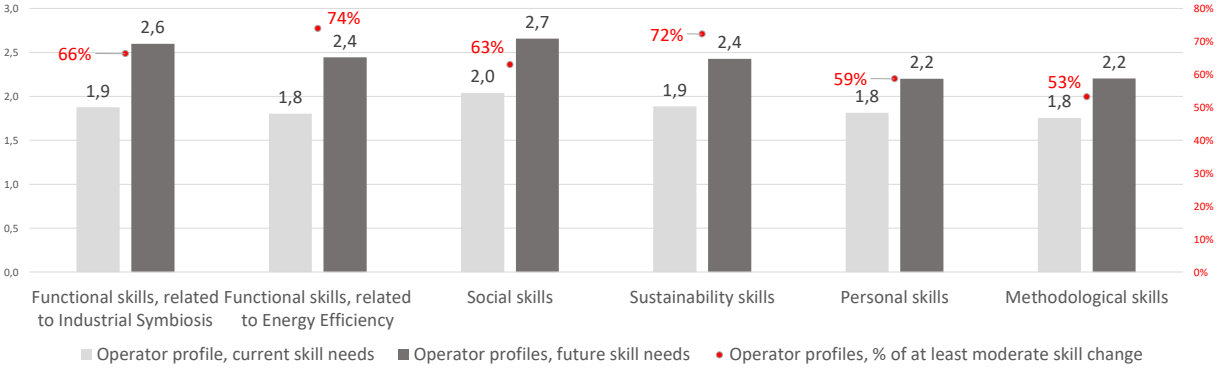
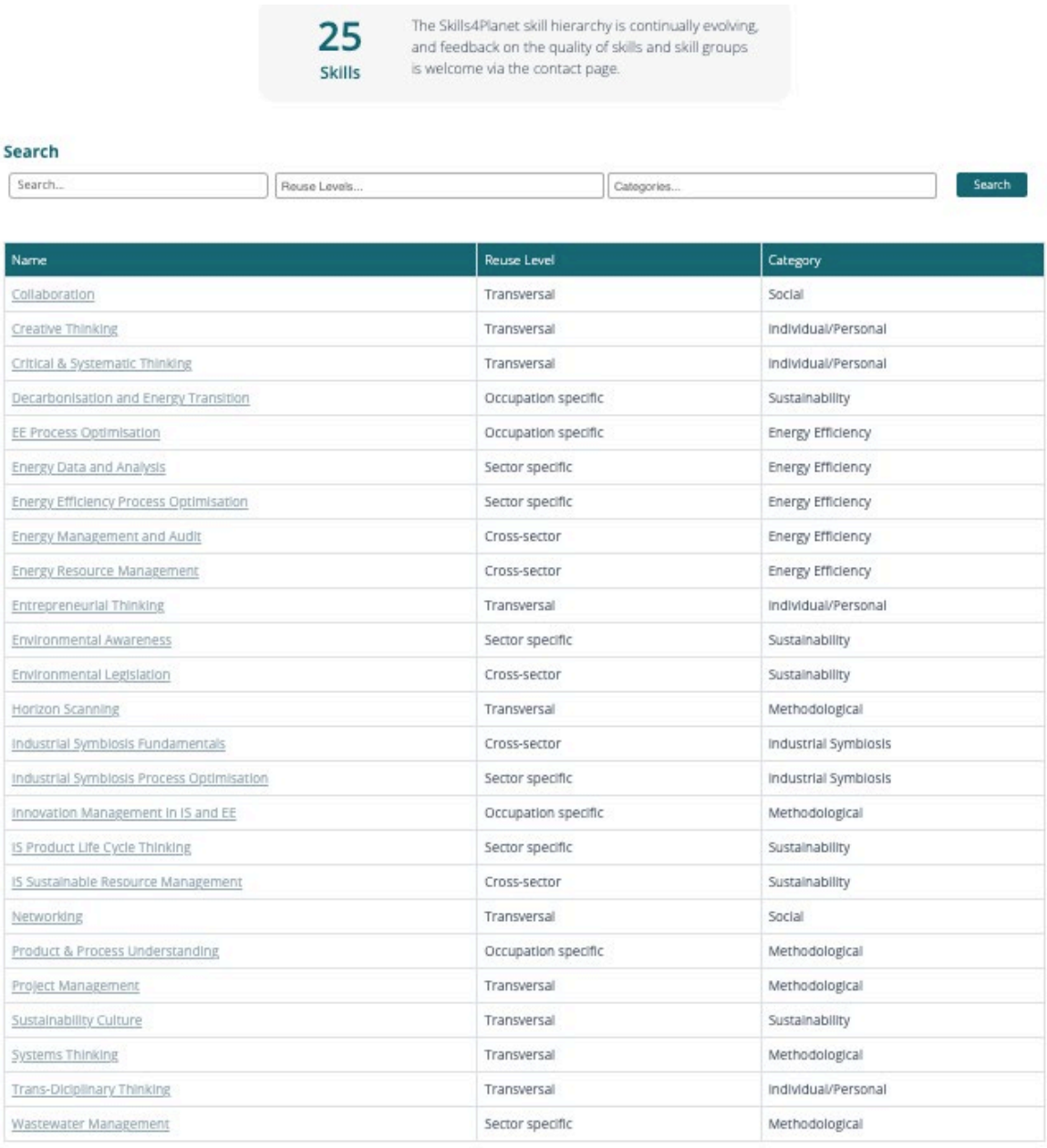


Figure 22: Development of operator profile skill needs *(Respondents: n = 23-25)*

[3] Level 0: Novice, Level 1 - Awareness / Basic Actor, Level 2 – Practioner, Level 3 – Expert, Level 4 – Master

Further steps were to define concrete skills and competences and to demonstrate the role of digital technologies and skills as a precondition for improving sustainability. This was done in line with the existing frameworks of skills, competence, and occupation (e.g. ESCO/ISCO occupations, but also managerial skills classifications (“Identification of potential opportunities”, “Fostering cooperation”, “Project planning and management”, “Initiative taking”) that fall under entrepreneurship competences according to the EntreComp Framework (Bacigalupo et al., 2016).

Finally, the following skills have so far formed the framework of SKILLS4Planet[4] for the creation of the Skill Directory.



Name	Reuse Level	Category
Collaboration	Transversal	Social
Creative Thinking	Transversal	Individual/Personal
Critical & Systematic Thinking	Transversal	Individual/Personal
Decarbonisation and Energy Transition	Occupation specific	Sustainability
EE Process Optimisation	Occupation specific	Energy Efficiency
Energy Data and Analysis	Sector specific	Energy Efficiency
Energy Efficiency Process Optimisation	Sector specific	Energy Efficiency
Energy Management and Audit	Cross-sector	Energy Efficiency
Energy Resource Management	Cross-sector	Energy Efficiency
Entrepreneurial Thinking	Transversal	Individual/Personal
Environmental Awareness	Sector specific	Sustainability
Environmental Legislation	Cross-sector	Sustainability
Horizon Scanning	Transversal	Methodological
Industrial Symbiosis Fundamentals	Cross-sector	Industrial Symbiosis
Industrial Symbiosis Process Optimisation	Sector specific	Industrial Symbiosis
Innovation Management in IS and EE	Occupation specific	Methodological
IS Product Life Cycle Thinking	Sector specific	Sustainability
IS Sustainable Resource Management	Cross-sector	Sustainability
Networking	Transversal	Social
Product & Process Understanding	Occupation specific	Methodological
Project Management	Transversal	Methodological
Sustainability Culture	Transversal	Sustainability
Systems Thinking	Transversal	Methodological
Trans-Disciplinary Thinking	Transversal	Individual/Personal
Wastewater Management	Sector specific	Methodological

Figure 23: Skills and Competence Selection

The SPIRE-SAIS skills assessment is based on four proficiency levels. A proficiency level refers to a measurement or assessment of an individual's competence or skill in a particular area

[4] https://hub.skills4planet.eu/competencemap/skills

of knowledge or performance. It represents the level of mastery or expertise that a person has achieved in a specific domain or skill set.

Proficiency levels serve as a useful tool for evaluating individuals' knowledge and skills, providing a standardized way to communicate their level of expertise. They help in setting learning goals, designing curriculum, assessing progress, and ensuring a common understanding of competency across different contexts. Proficiency level frameworks also assist in identifying areas for improvement, tailoring instruction, and providing targeted support to help individuals advance to higher levels of proficiency.

In SPIRE-SAIS project, each skill has been defined by four levels of proficiency, that will appear when choosing the level. Figure 24 shows the skill “IS Product Life Cycle Thinking”, in this skill there is a short description of the skill as well as short description of the tasks that need to be accomplished in each level. Besides, for each proficiency level there are learning outcomes breaking down in Factual, Theoretical, Cognitive and Practical.

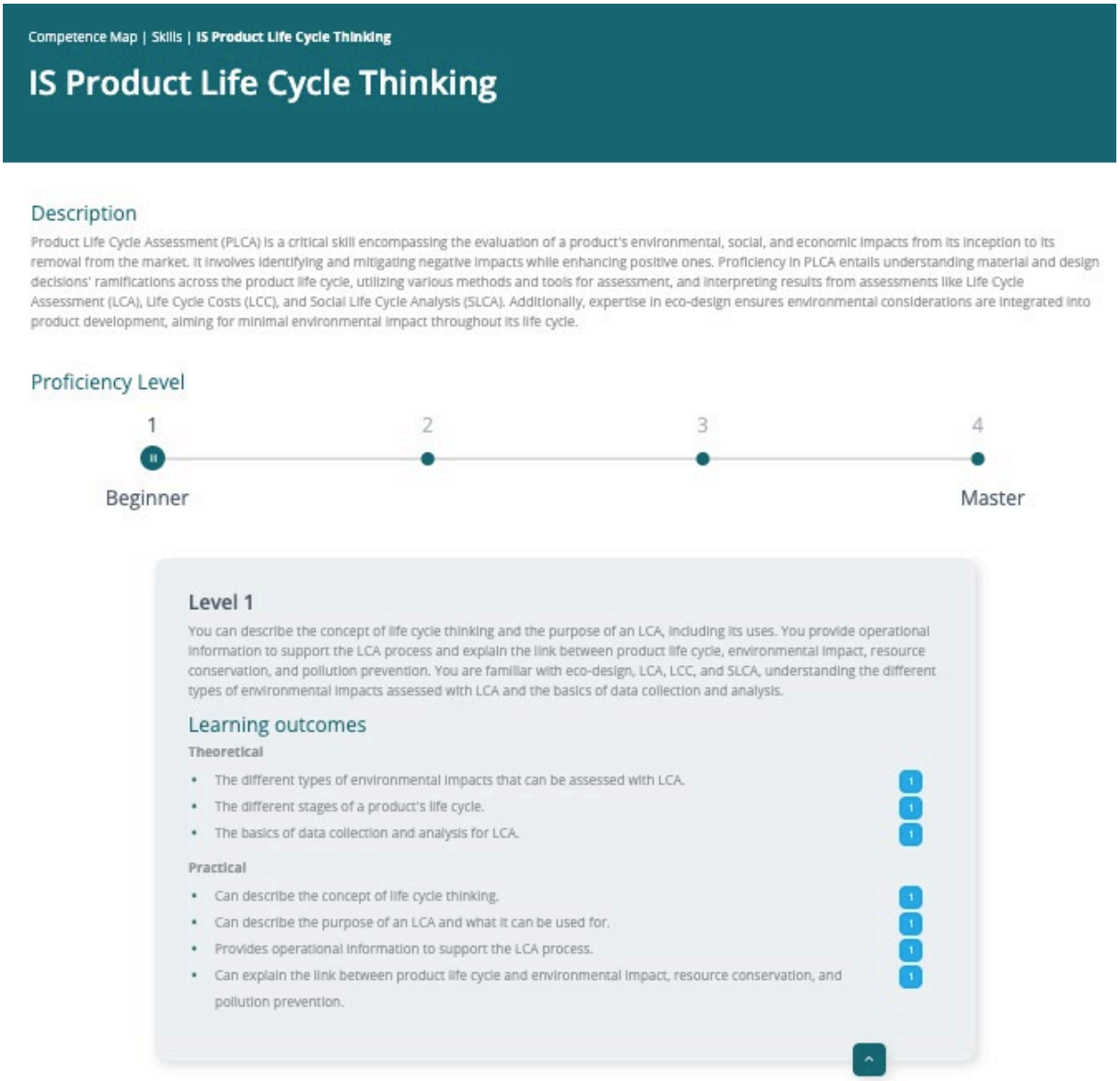


Figure 24: Skills divided in term of proficiency level and learning outcomes in SKILLS4Planet

Figure 25 is an example of the skill, “Hydrogen Combustion and Heat Transfer” and the learning outcomes for Level 3. Besides, the European Qualification Framework (EQF) was introduced that help to categorized the learning outcomes for knowledge in Factual and Theoretical, as well as skills in cognitive and practical. As shown in Figure 25 the eight EQF levels are aligned with each learning outcome and proficiency level defined in SKILLS4Planetto ensure cross-border mobility of learners and workers, promote lifelong learning and professional development across Europe.

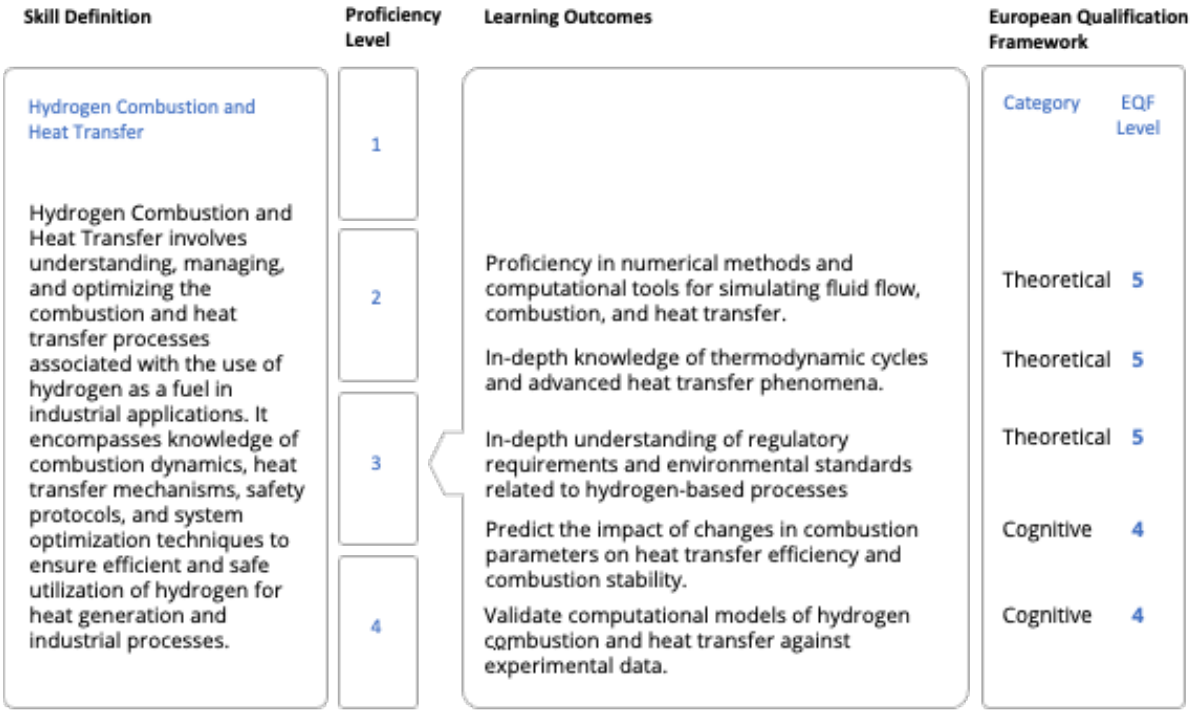


Figure 25: Description of Proficiency Levels of the skill for the "Hydrogen Combustion and Heat Transfer"

These definitions are part of the Self-Assessment (chapter 2.2.8) tool to guide the learners to identify their recent proficiency level for a particular skill. Figure 26 is an example of this assessment to show as example of the use of the description define in the skill.

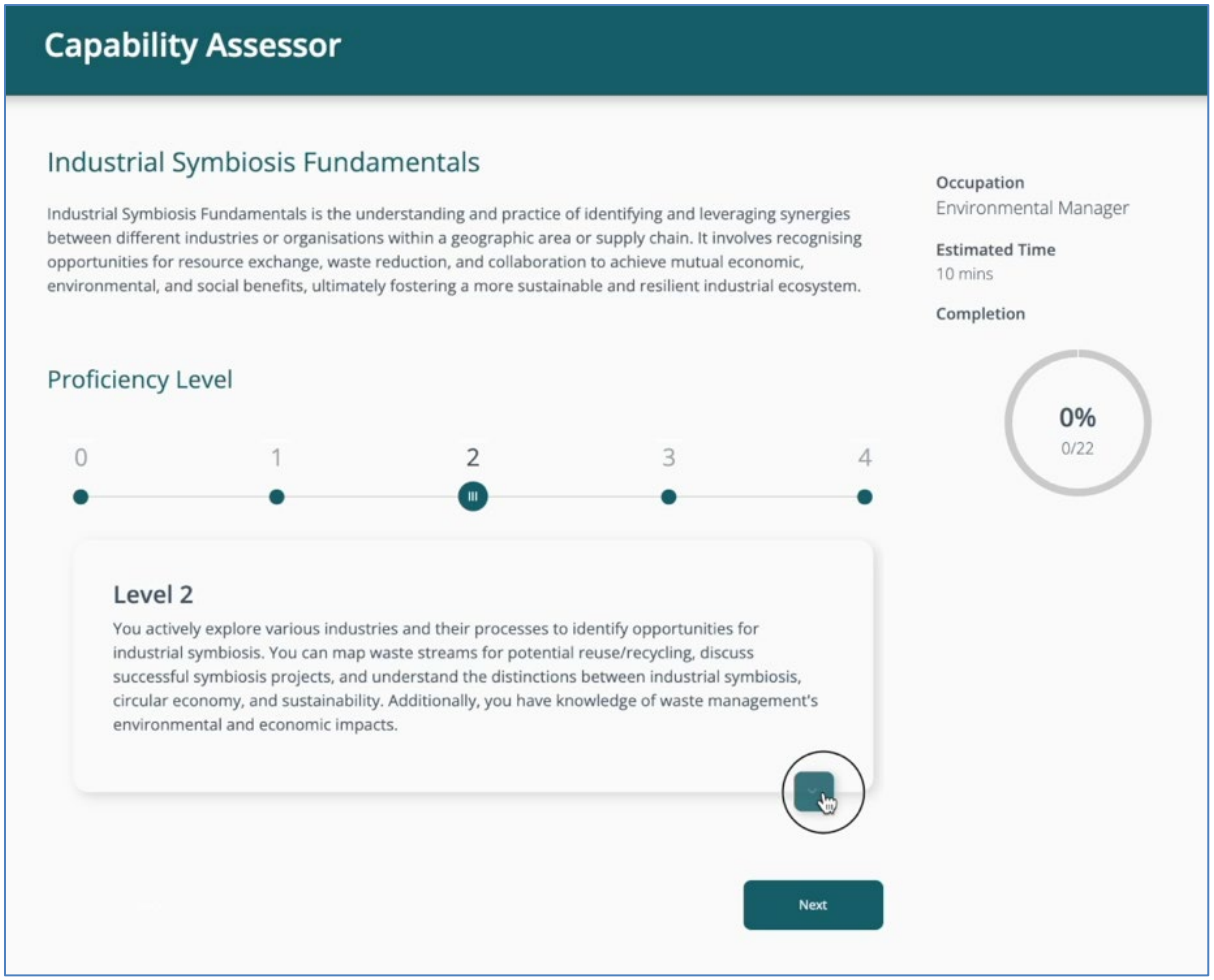


Figure 26: Proficiency levels a spart of the self-assessment tool

2.2.6 Qualification and Education System Mapping

To avoid a standalone solution, the selected job profiles and skills categories for Energy Efficiency and Industrial Symbiosis are aligned as much as possible with relevant European tools. This will ensure a continuous development and integration of the industry driven skills demands of EE and IS in existing and further to be developed formal occupations. Therefore, we integrated besides EQF levels also the ESCO/ISCO description within our Job Profile Description and Skills Assessment Template (see ISCO/ESCO code in Figure 19 above) and align the SAIS Job Profiles with the equivalent ESCO occupation (see Table 1). It becomes evident in this overview that IS and EE skills are an integrated part of the broader job functions and occupations. Therefore, beside the Industrial Symbiosis Facilitator, no new jobs are created so far but the existing job functions and occupations will have to upskill existing or add new skills on behalf of IS and EE.

Cross/sectoral Generic Job Profiles			
Area	**Level**	**Job Profile**	**Equivalent ESCO occupation**
Production	Management	Production Manager	Industrial Production Manager
Production	Operational	Production / Processing Line Operator/Foreman	Production Engineering Technician
Functional	Management	Materials / Products Manager	Product Manager Materials Engineer
Functional	Operational	Materials Operator/Foreman	Production Supervisor
Functional	Management	Energy Manager	Energy Manager
Functional	Operational	Energy Technician	Energy Analyst
Functional	Management	Environmental Manager	Environmental Engineer
Functional	Operational	Environmental Technician	Environmental Technician
Functional	Management	Waste Manager/Responsible	Waste Management Supervisor
Functional	Operational	Waste Management Technician	Waste Management Supervisor
Functional	Management	Maintenance Manager/Supervisor	Maintenance and Repair Engineer
Functional	Operational	Maintenance/Repair Operator/Foreman	
		(a) Water, Gas, Stream, Air Foreman	Maintenance and Repair Engineer
		(b) Mechanical/Electrical Technicians	Electrical Supervisor Electromechanical Engineering Technician
Functional	Management	Purchase Manager	Purchasing Manager
Functional	Operational	Purchase Technician	Purchaser
Functional	Management	Logistic Manager	Logistics and Distribution Manager
Functional	Operational	Logistic Technician	Logistics Engineer
Functional	Management	Legal/Regulatory Manager	Regulatory Affairs Manager
Functional	Operational	Legal/Regulatory Technician	Environmental Engineer
Functional	Management	HR Manager	Human Resource Managers
Functional	Operational	OHS Responsible	Environmental technician
Functional	Management	Quality Manager (quality of recycling materials)	Industrial Quality Manager
Functional	Operational	Quality Technician	Quality Engineer

Table 1: Alignment of Selected Job Profiles with ESCO Occupations

However, we have to create links between skills, knowledge, and learning outcomes, esp. when it comes to connecting industry requirements with the education systems. Learning outcomes are systematically promoted in the EU policy agenda for education, training and employment - interlinking important European tools, notably the European Qualification Framework (EQF), and increasingly influencing the definition and writing of qualifications and curricula as well as the orientation for assessing teaching and training. Therefore, learning outcomes could be seen as a connecting link between industry demands and formal education and training curricula.

Learning outcomes (as described in Cedefop, 2017) developed for specific learning processes (of qualifications, training courses, learning units, or non-formal learning) are usually defining knowledge, skills and competences that learners are expected to demonstrate by the end of the learning process (see relations in Figure 27). Based on the selected SPIRE-SAIS functional job profiles (composed by a set of tasks) and the related skills (to perform these tasks), knowledge has to be identified that is required to gain those skills. Against this backdrop, learning objectives and outcomes including knowledge, skills and competence are defined as the ground for curricula of training programs, courses and micro-credentials ("evidencing learning outcomes acquired through a short, transparently-assessed course or module" (European Commission, n. d.)).

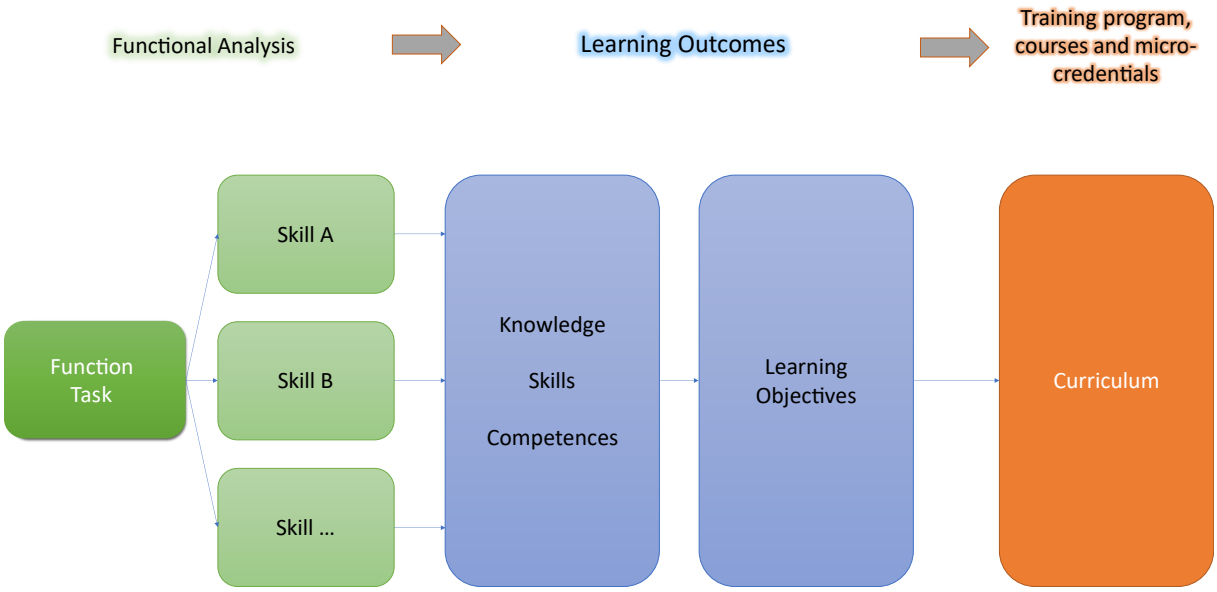


Figure 27: From Functional and Skills Analysis to Learning Outcomes

This Skill and Learning Outcome analysis were uploaded into SKILLS4Planet. The following image shows 4 qualifications uploaded.

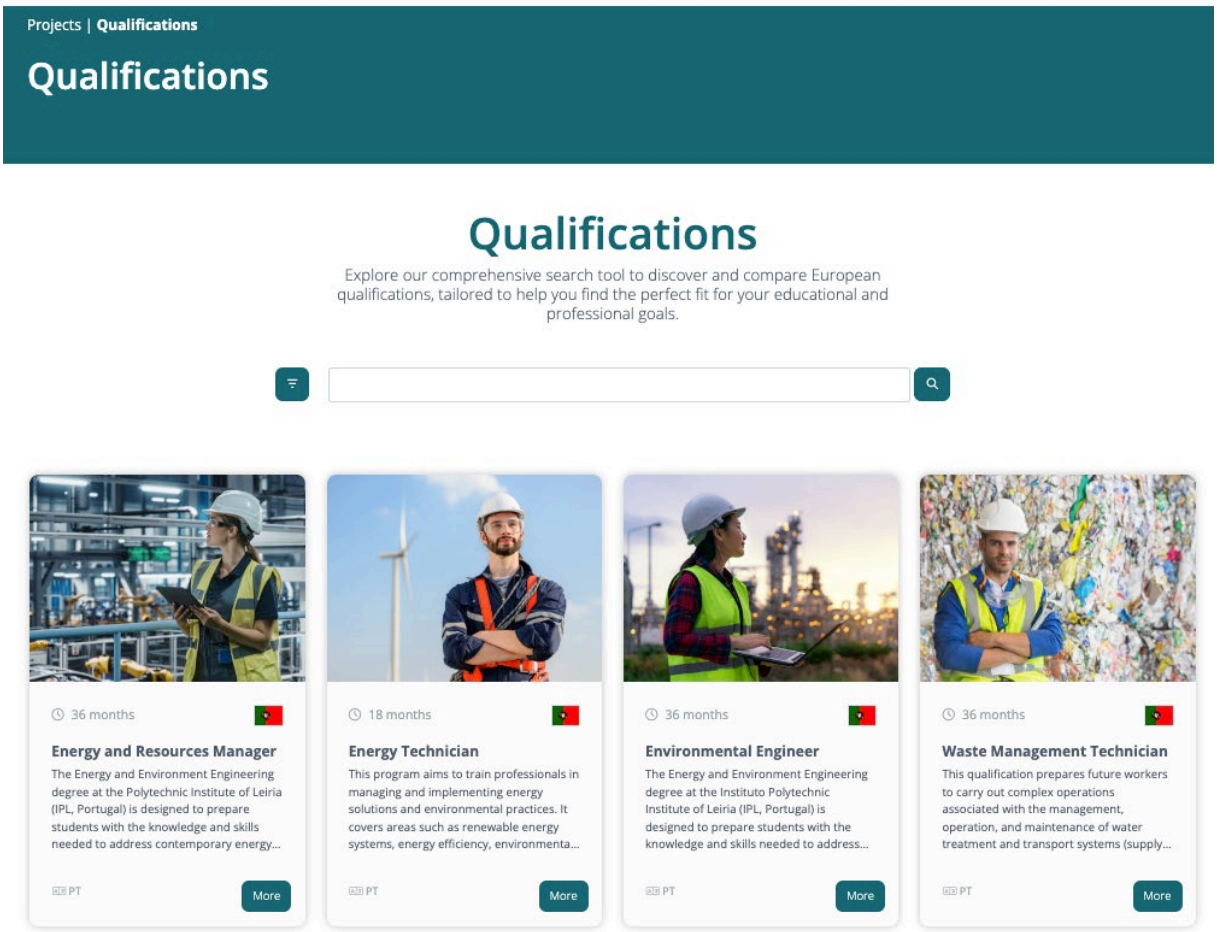


Figure 28: Qualifications Uploaded in SKILLS4Planet

2.2.7 Learning Solution Mapping

Learning Solution Mapping with occupation thru the skill directory using the learning outcomes to connect is a strategic approach that aligns learning and development initiatives with the specific skills and competencies needed within an organization. This process is essential for organizations looking to optimize their learning and development efforts. It aligns training programs with strategic objectives, targets specific skill gaps, optimizes resource allocation, measures impact effectively, supports talent development, enhances organizational agility, and ensures compliance.

The following diagram shows the skill “Hydrogen Combustion and Heat Transfer”, which is connected with Learning Solutions like videos, e-learning, articles, among others. How in-depth the learning outcomes are explained in the learning solutions depends on the selected EQF 8-level.

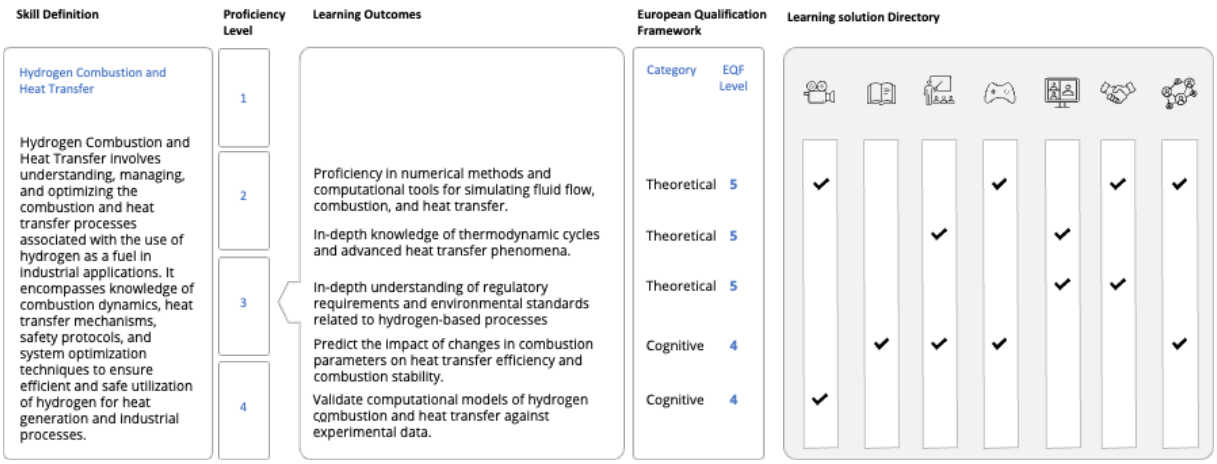


Figure 29: Mapping Learning Outcomes with Learning Solutions

In conclusion, Learning Solution Mapping with a skill directory is essential for organizations looking to optimize their learning and development efforts. It aligns training programs with strategic objectives, targets specific skill gaps, optimizes resource allocation, measures impact effectively, supports talent development, enhances organizational agility, and ensures compliance. By adopting this structured approach, organizations can build a skilled and adaptable workforce capable of driving sustained growth and success in an increasingly competitive global market.

2.2.8 Skill Gap Analysis and Assessment

Skill gap analysis is crucial for organizations as it identifies the disparity between employees' current skills and the skills required to meet business goals. By addressing these gaps, companies can enhance employee performance, foster innovation, and adapt to market changes effectively. Additionally, it aids in strategic workforce planning, reducing recruitment costs by upskilling current employees rather than hiring new ones. Ultimately, skill gap analysis supports organizational growth and long-term success by aligning talent development with business objectives.

Besides, this analysis is vital for individuals as it identifies areas where their current skills fall short of job requirements or career aspirations. By understanding these gaps, enables individuals them to stay competitive in a rapidly changing job market, adapt to new technologies, and meet industry standards. Additionally, it boosts confidence, job satisfaction, and performance.

On other words, skill gap analysis empowers individuals to take control of their professional growth, achieve personal goals, and secure better career opportunities.

European guidelines for validating non-formal and informal learning (Cedefop, 2023) provide a detail analysis and description of subjective and objectives evaluations methods. The following diagram show how those types of evaluation are connected with Learning Outcomes for a particular skill.

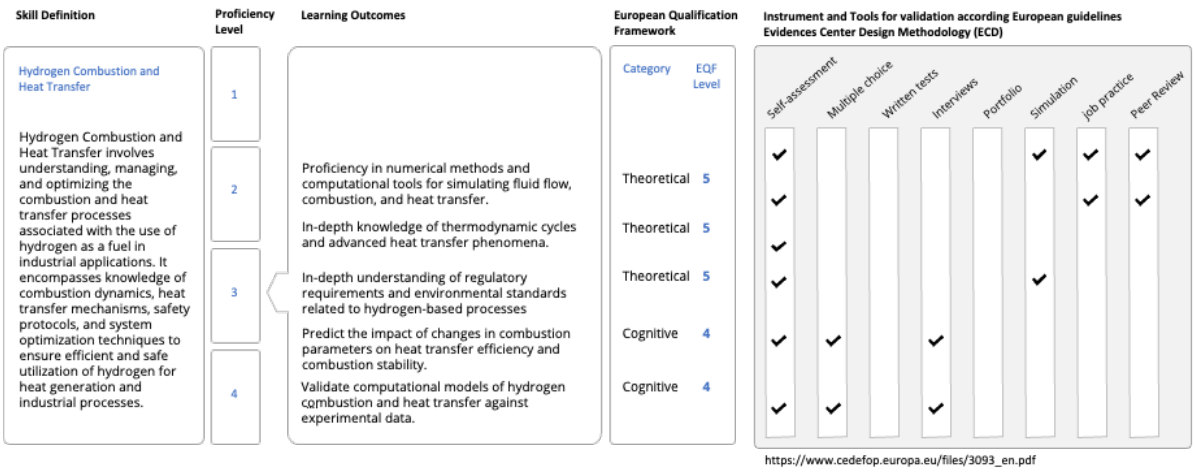
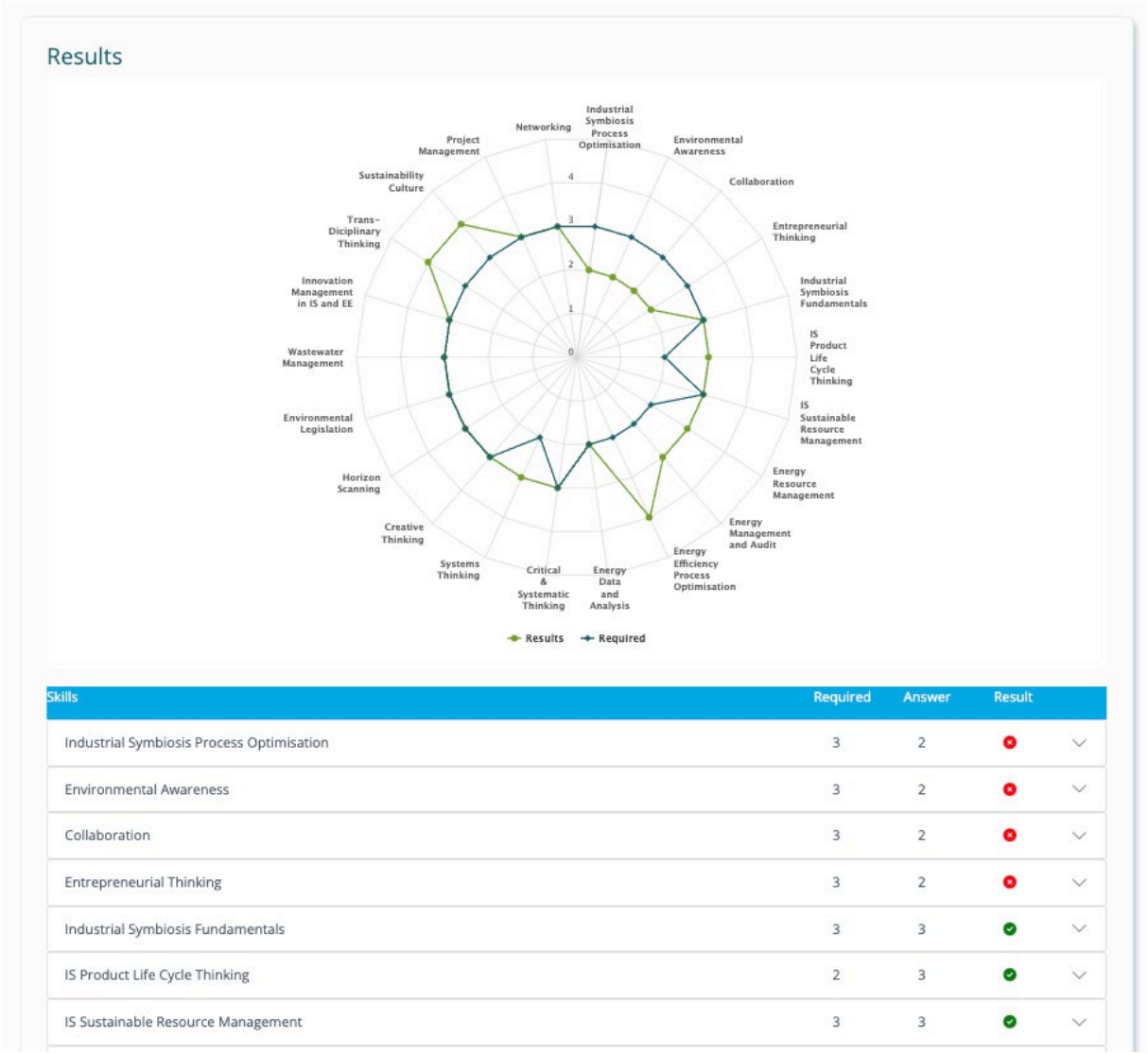


Figure 30: Mapping Learning Outcomes with Assessment Tools and Methods

SPIRE-SAIS developed a Self-Assessment tool[5] to empowers individuals to reflect on their abilities, recognize areas for improvement, and take ownership of their development. This introspective process encourages self-awareness and accountability, leading to more engaged and motivated learners. The objective is to foster a growth mindset, enabling individuals to set realistic goals, seek relevant learning opportunities, and track their progress.

[5] https://cdn.hub.skills4planet.eu/assets/app/ASMT/index.html#/assessment/intro



Skills	Required	Answer	Result
Industrial Symbiosis Process Optimisation	3	2	✗
Environmental Awareness	3	2	✗
Collaboration	3	2	✗
Entrepreneurial Thinking	3	2	✗
Industrial Symbiosis Fundamentals	3	3	✓
IS Product Life Cycle Thinking	2	3	✓
IS Sustainable Resource Management	3	3	✓

Figure 31: Skill Gap Analysis report generated with Self-Assessment tool

2.3 *VET System Support*

The VET system review for skills demands on IS and EE is reflecting VET systems in five selected countries, representing different VET structures: Germany, Italy, Poland, Portugal, and Spain. Following this analysis good case studies were gathered in a repository. A selection of them is illustrating the provision of skills relevant for IS and EE in this chapter. Additionally, the Skills Matrix framework, covering four most relevant job profiles (Energy Manager, Energy Technician, Waste Manager and Waste Technician) and three selected countries (Germany (North Rhine Westphalia), Italy (Emilia-Romagna region) and Portugal), was created (see D4.2 (Visionary Analytics, 2024b) and D4.3 (Visionary Analytics, 2024a)).

2.3.1 Key Features of VET Systems

We have compared the five analysed VET systems according to few key elements for an integration of SPIRE-SAIS industries' skills requirements (as summarised in Table 2). Some commonalities and differences in the design and recent general reforms of the systems analysed are presented below:

- **Decision-making level:** Highly centralised VET systems (Poland, Portugal) do not allow for much adjustment of the curricula to address local labour market needs. On the other hand, there have been calls to create a national skills strategy in the highly decentralised Italian system to provide a unified framework and better streamline regions' policies. Individual VET institutions have little autonomy to adjust courses in all countries analysed.
- **Curricula development:** Regardless of the distribution of responsibilities between central and regional governments, the adjustment of curricula is a long and complicated process that involves many stakeholders[6]. This does not allow for a swift adaptation of the teaching content to quickly evolving labour market needs.
- **VET duality:** All countries have introduced reforms to include a predominantly work-based pathway in VET (based on the German dual VET model) and/or to include more of practical training in the school-based pathways. It is yet unclear how successful these reforms will prove in practice.
- **Inclusion of industry stakeholders:** Industry seems to be playing a much more active role in countries with work-based pathways deeper entrenched in their VET systems (mainly Germany, also Spain) than in historically school-based systems (Italy, Poland, Portugal).

	Italy	Germany	Poland	Portugal	Spain
Key decision-making level	Regional	Balance between federal, regional, and local	Central	Central	Balance between federal and regional
Standardisation	High	High	High	High	High
Permeability	High	Low to medium	High	High	High
Accessibility for adult learners	Yes (separate pathways)	Yes (only some programmes)	Yes (mainly separate pathways)	Yes (separate pathways)	Yes (only some programmes)
EQF levels covered	EQF 3-5	EQF 2-4	EQF 2-5	EQF 2-5	EQF 3-4
Predominant delivery mode	School-based	Work-based	School-based	School-based	School-based
Recent key reform	Introduction of dual VET (2015)	Adjustment and development of CVET (2020)	Restructuring of VET, incl. expansion of incentive system and work-based VET (2016)	Development of National Credit System (2017)	Introduction of dual VET (2012)

Table 2: Overview of Selected VET Systems *(source: Visionary Analytics, 2024c)*

[6] It might involve adjustment of occupational standards based on cooperation between ministries, bodies responsible for the national qualification repository and sectoral bodies; developing or changing of curricula following consultations with business and various advisory bodies; adapting the new standards and adjusting to local needs by regional authorities; and adopting the new curricula by VET schools. It can take years before graduates with new skills sets enter the market (e.g., estimated 3 years in Poland for curricula development and another 3-5 years for training of the first cohort).

Further important elements discovered are the strategic planning and implementation of IS- and EE-related green skills in national policies and VET activities. Each are addressed in separate sub-sections below.

2.3.2 Strategic Planning: IS- and EE-related Green Skills in National Policies

With the exception of Germany's 'National Action Plan for Sustainable Development in Education' (National Platform on Education for Sustainable Development, 2019), at the time of detailed desk research (2022) no specific strategies for green skills delivery have been identified in the target countries. Broader national educational strategies rarely explicitly mention green skills[7], but they tend to acknowledge the broad need to re-adjust curricula to the changing labour market needs. They also tend to highlight the teaching of transversal skills (e.g. entrepreneurship, adaptability, creativity) and practical technical skills (also evidenced in the shift towards dual VET systems).

At the same time, although industrial and environmental policies tend to recognise changing skills needs and often call for further reforms of the VET system, they rarely involve concrete action plans in the education sector. Another common ground of these policies is the inclusion of awareness raising activities targeted at the broader public. For example, the Italian 'Energy Efficiency Action Plan' (ENEA, 2017) includes an information campaign about Energy Efficiency directed at a broad audience of end-users. This showcases the often very narrow understanding of sustainability education, focused on giving information and shaping behaviour and detached from skills training.

The German Federal Institute for VET's initiative ***'Sustainability in Vocational Education'*** aims at developing new learning modules and didactic materials (e.g. guidelines on sustainability at work), creating new VET curricula and updating existing ones to include issues such as environmental awareness, green skills, sustainability, and circular economy. The initiative has also developed didactic materials such as guidelines on sustainability at work and in production processes. While the focus of this initiative was not exclusively on the EIIs, many of the new learning modules, curricula, and materials do concern EIIs-relevant occupations.
The Spanish government's initiative ***'Empleaverde'*** provides funding for projects supporting the creation of jobs in the green and 'blue' economy. Organisations can apply for funding, for example, to upskill for the employed and the unemployed, conduct research about innovative ways to create new jobs and connect Spanish entrepreneurs with relevant actors and expertise EU-wide.
The project ***'Future skills trends in Emilia-Romagna'*** is an example of a regional policy-supporting initiative in Italy. It identifies key competencies needed to facilitate sustainable development in selected industries (including agri-food, mechatronics and automotive, construction) and digital and green skills that should be provided through the regional VET training offer. The document can be used by professionals in the education sector to (re-)design curricula and by policymakers to update skills standards.

[7] For instance, in Poland, a term "skill of the future" is used.

In Portugal, the ***'Environmental Education Framework for Sustainability'*** constitutes a guiding document for implementation of this theme in the scope of Citizenship and Development, a subject area that integrates the curriculum in the different cycles and levels of education and teaching. The framework, which is flexible in nature, can be used in very different contexts, as a whole or in part, through the development of projects and initiatives that aim to contribute to the personal and social development of students. Eight transversal themes are proposed to all cycles and levels of education and teaching, constituted by sub-themes and objectives.

Table 3: Good Practices of IS and EE-related Skills Provision: Policy Level (source: D4.1; Visionary Analytics, 2024c)

2.3.3 Implementation: The Delivery of IS- and EE-related Green Skills in VET

Implementation of IS- and EE-related green skills differs at national and international/ EU level. Each context is addressed separately below.

National context

The provision of green skills in VET can be analysed at two key levels. Firstly, national VET systems provide some specific programmes focused on sustainability:

- The proliferation of sustainability-focused programmes varies across the selected countries. Italy seems to be leading the way, with a well-developed offer of tertiary-level academic and non-academic (VET) pathways. VET providers in Spain, Germany, and Portugal also offer a good number of dedicated courses. Poland at the time of research offered only one course focused on renewable energy delivered by a limited number of VET schools.
- These programmes tend to focus on advanced, technical, occupation-specific green skills.
- EE courses are much more prevalent than IS courses. For instance, in Italy, roughly one in ten of all VET courses at the post-secondary level fell into the category "Energy Efficiency". No courses explicitly focused on IS have been identified in any targeted country.

Secondly, green skills training can be included as a horizontal element in other VET courses:

- Only the German VET system incorporates green skills training in a structured manner in all VET courses. In other countries, green skills provision in general VET courses tends to be fragmented, incomprehensive and often dependent on the initiative of individual schools. For example, within the Portuguese National Citizenship Education Strategy, it is up to the school to implement its citizenship education strategy (which involves the teaching of Sustainable Development and Environmental Education).
- In almost all countries, the importance of extracurricular activities, often provided by organisations outside the VET systems, has been emphasised. Therefore, the delivery of green skills at national or lower levels is more likely to be non- or informal and provided on ad-hoc basis.

'Green Jobs in the Metal Industry' (Germany) focused on developing green skills and jobs in the German state of Brandenburg. The project developed upskilling schemes for green skills, based on a thorough evaluation of which green skills and jobs were relevant for the industry. The training was offered to secondary VET students/ trainees, employees, and the unemployed. The project was implemented by a wide partnership of national and international stakeholders.
The Spanish Association for Standardisation and Certification's **training programmes about Circular Economy** are aimed both at companies and individuals. Training has been delivered through online and in-person sessions, experts' speeches, and in-company training. Topics are cross-sectoral and include circular economy, energy management, and environment management.
In Portugal, ***'Network of Coordinator Teachers of Environmental Education Projects'*** promotes environmental education. The Network has contributed to the promotion of various initiatives, recognition of projects, inclusion of content in school curricula and the creation of a network of teachers with technical-pedagogical skills for the coordination and promotion of projects in communities, developed with environmental NGOs.

Table 4: Good Practices of IS and EE-related Skills Provision: Implementation Level, Source: Deliverable 4.1

International/EU context

In most countries, a significant share of green skills training is being delivered outside formal VET, as project-based, ad-hoc activities. The role of international stakeholders in this area is important – firstly, many successful initiatives are implemented internationally or with the support of international stakeholders[8]. Secondly, some of the nationally or regionally organised green skills training initiatives depend on international (esp. EU) funding. In Italy, for example, the European Social Fund is a major funding source for upper-secondary VET and CVET.

The blended learning course ***'Junior Expert in Circular Economy (JECE)'*** is a one-year post-secondary VET programme. It targets young Europeans living in the Emilia-Romagna region (Italy), with a focus on people who are neither in employment nor education nor training (NEET). This cross-sectoral course aims to equip the participants with the necessary skills for sustainable development and circular transition in the economy and society. The 2022 edition is financed by Emilia-Romagna Region and the European Social Fund (ESF) and organised by Centoform – a regional VET provider, with the support of a range of national and international partners. It follows a certification scheme based on EQF, ECTS and ECVET.

[8] However, a significant downside of such international, project-based activities is their lack of sustainability – many promising initiatives simply discontinue after the funding dries up.

The Polish Future Industry Platform is currently developing ***'Guide 4.0 - how to educate the competencies of the future?'***. The initiative involves the development of a course for secondary school teachers to introduce methods for training the competencies of the future. Additionally, educators will have access to an online *Guide 4.0* to facilitate mapping students' skills and prepare individual or group skills development programmes. They will also have access to educational tools, a manual, and tutorials developed during the project. The project is being delivered in partnership with International Development Norway (a Norwegian consulting and management company specialising in green energy, innovation, and education) and funded by the European Economic Area (EEA) and Norway Grants.

Table 5: Good Practices of IS- and EE-RELATED Skills Provision: International Dimension

2.3.4 Important results/impact for the Blueprint from the VET Perspective

To sum up, there are several key gaps and barriers emerge across countries where SPIRE-SAIS could contribute:

- **Educators' readiness:** Teachers often lack competencies how to teach green skills effectively.
- **Poor evidence base:** Robust assessments of relevant educational programmes' effectiveness are needed to replicate the good practices across Europe.
- **Course structure and tools:** Establishing a cross-sectoral IS/EE module that could be integrated into different occupational trainings could be helpful. Ideally, it should be accompanied by easily accessible didactic materials and guidance for education providers on how to deliver it best.
- **A uniform skills recognition system:** Green skills are not easily verified and certified, which discourages learners (as they rarely receive a formal certificate on completion of training) and hinders skills tracking and forecasting.

Other important barriers include:

- **Lack of coherent greening policies:** The responsibility for green skills delivery is usually split between many stakeholders (educational, industrial, and environmental ministries, regional governments, VET schools, civic organisations, etc.) and is not guided by a single overarching strategy.
- **Insufficient funding:** Funding for green skills tends to be fragmented and short-term.

2.3.5 Skills Matrix

The Skills Matrix was created by integrating strategies from the ESSA Blueprint project and following the European guidelines, such as European Skills, Competences, Qualifications and Occupations (ESCO) and the European Qualification Framework (EQF).

The cross-sectoral matrix was filled with information based on:

- **Identify Job Profiles and Skills**: using the relevant job profiles and skills for IS and E-related work functions four job profiles were selected for the Matrix (Energy Manager, Energy Technician, Waste Manager and Waste Technician) based on their importance/ added value, coverage of IS and EE impacts and sustainability/ feasibility needs of the project (for a more detailed explanation see D4.2; Visionary Analytics, 2024b);

- **Align with EU frameworks**: industry inputs were translated to “official” terms, using ESCO database for detailed occupation descriptions and codes and skill listings.
- **National Level Descriptions**: analyse how these ‘translated’ job profiles are described in selected three partner countries (i.e. Germany (North Rhine Westphalia), Italy (Emilia-Romagna region) and Portugal), if applicable, looking into Europass certificates and national qualification frameworks;
- **Assess Skills in VET**: assess how national VET systems address IS and EE skills demands, assessing qualifications and program content.

To sum up, the matrix is comprising the information, shown in Table 6 below:

Job and skills	Description of the job in EU frameworks	Job & Qualification in country	National Frameworks	Integration in EU Framework Categories	IS and EE skills readiness
• Job profile alternative • Job profile titles • Skill needs • Skill level	• ESCO group label • ISCO group code • ESCO occupation level and code • ESCO alt. Labels • ESCO skills	• ESCO group label in country • Job labels in country • Qualification label	• National qualification framework labels of occupation and qualification • list of national VET programmes delivering those • duration	• Europass certificate • ISCED info • EQF info • ESCO integration of qualification	• Skill needs • Skill levels • Skills sufficiently addressed by qualification • Integration of skill in qualification, • Addressed in VET programme, learning outcomes indicated

Table 6: Matrix information summary.

This allows three main functions foreseen:

- **Linking Job Profiles, Occupations and Qualifications**: the matrix connects job profiles (used by industry) to broader occupational and qualification frameworks. This helps employers identify relevant qualifications for job profiles and supports international employee mobility.
- **Assessing VET programme relevance**: it evaluates how well VET programmes meet the industry’s IS and EE skills needs. This supports identifying gaps and strengths in VET programmes, aiding both industry and VET providers in providing directions for improving their training and recruitment.
- **Integrating EU Frameworks into national systems**: the Matrix tracks how well national VET systems align with European frameworks such as EQF, ESCO, and Europass. This facilitates institutions in harmonising relevant VET standards across countries.

This structured approach ensures the Matrix is comprehensive, future-oriented, and applicable tool across various European countries. Overall, it contributes to improving the alignment of industry needs with VET provisions and fostering international standards in VET.

The matrix is expected to be mostly useful to the representatives of the industry and VET providers. For example, a company searching for candidates for a particular job profile will know what qualifications are directly linked to this job profile. Moreover, the matrix identifies relevant national qualifications that exist in different countries. Industry representatives will know whether the qualification acquired by a candidate in a foreign country is relevant for the position (job profile) they need to fill. This is expected to facilitate international mobility of employees.

3 The Supply Side: Strategies and Measures

The SPIRE-SAIS Blueprint is answering the industry skills demands with the establishment of **Skills Intelligence** via a **Foresight Observatory** and the **Online Training Platform SKILLS4Planet**, in the further course by establishing a **European Training Community for Industrial Symbiosis**, supported by **Image and Recruitment** concepts.

3.1 *Skills Intelligence via a Foresight Observatory*

The supply side of SPIRE-SAIS is ensuring the continuous update of the demand side and a timely provision of training measures and support, continuously updated. Therefore, we established **Skills Intelligence via a Foresight Observatory** as the core coordination element of SPIRE-SAIS, complemented by the running online training platform SKILLS4Planet and a to be established Sectoral-National-Regional Community of Training Practice. Within the Observatory:

- Technology and skills foresight will be done on a regular basis, e.g. via a (bi-)annual survey "**Industrial Symbiosis Technology and Skills Radar**".
- Technological and economic development and skills related projects will be listed in a **Project Repositor**y, continuously updated.
- Recommendations, indicators and incentives will be developed pushing the focus on qualifications, competences and skills for Industrial Symbiosis and Energy Efficiency.
- Pilot measures and test options for IS and EE skills adjustments will be supported and fostered, including looking for (European and national) funding schemes.
- The **Online Training SKILLS4Planet Platform** is giving immediate answers to the industry skills demands (see in detail section 3.2.2 and D5.1; Muract et al., 2024).
- Industry image campaigns for recruitment and talent attraction will be supported focusing on IS / EE skills and qualifications (see in detail section 3.3).
- Leadership is defined in an Open Coordination way, dividing responsibilities between the main and willing actors.

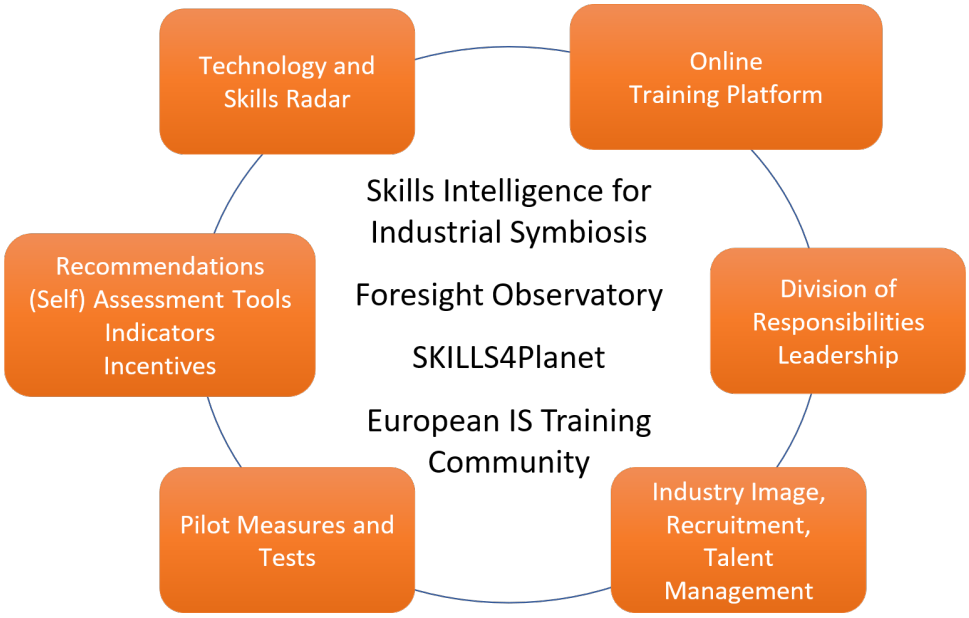


Figure 32: Foresight Observatory and Training Community

The *Foresight Observatory* is the core element of the coordination of SPIRE-SAIS and Skills Intelligence for Industrial Symbiosis, including a regular survey that provides insight into recent and coming technological and economic developments concerning Industrial Symbiosis and related Energy Efficiency skills demands.

To setup a regular *Industrial Symbiosis Technology and Skills Radar* we evaluated in the survey 2024 the comprehension ability, the required time as well as the usefulness of the questionnaire.

Regarding the **comprehension** the biggest problems seem to occur in the assessment of the current and future skill levels (see Figure 33). About one in three participants disagreed with the statement they had no problems evaluating the future skill levels where as one in three participants showed problems with regard to the current skill levels. This suggests that the ability to abstract from experience of the Energy Efficient Industries to numerical information on a numerical scale of skill level is a challenge, especially with the regard to future scenarios.

Also, much disagreement was detected in relation to the **time required** to complete the questionnaire – around 23% of respondents disagreed or strongly disagreed) with a statement saying the time to complete the questionnaire was reasonable.

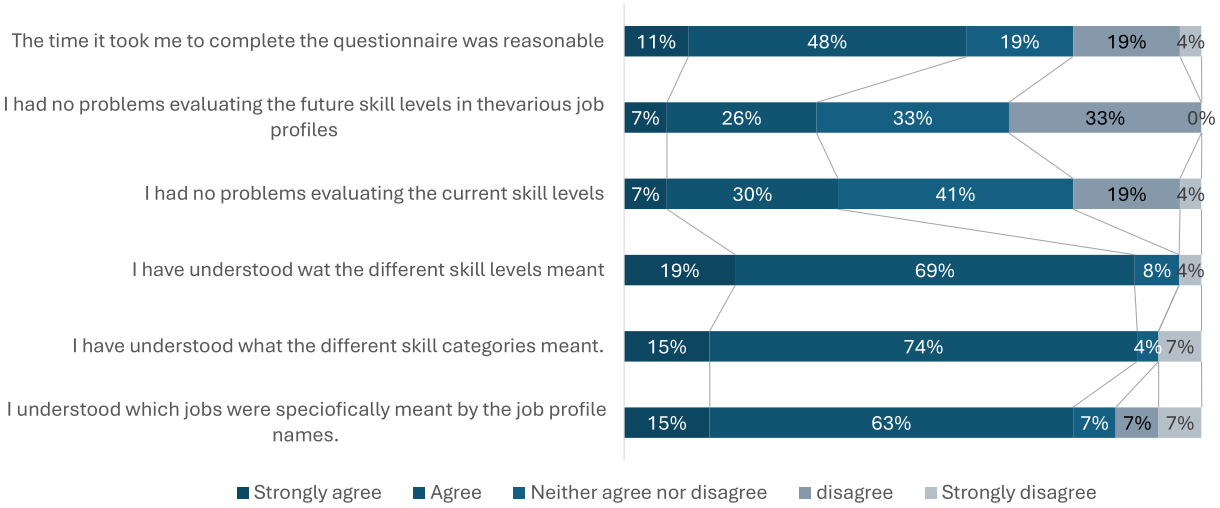


Figure 33: Disagreement and agreement to statements for evaluation *(Respondents: n = 27)*

With regard to the **usefulness of the questionnaire**, it is accompanied by moderate expectations. The category “moderately useful” was the most frequently mentioned with regard to identifying trends and raising awareness (see Figure 34). But at the same time only a few participants stated that the survey was not useful at all or only slightly useful.

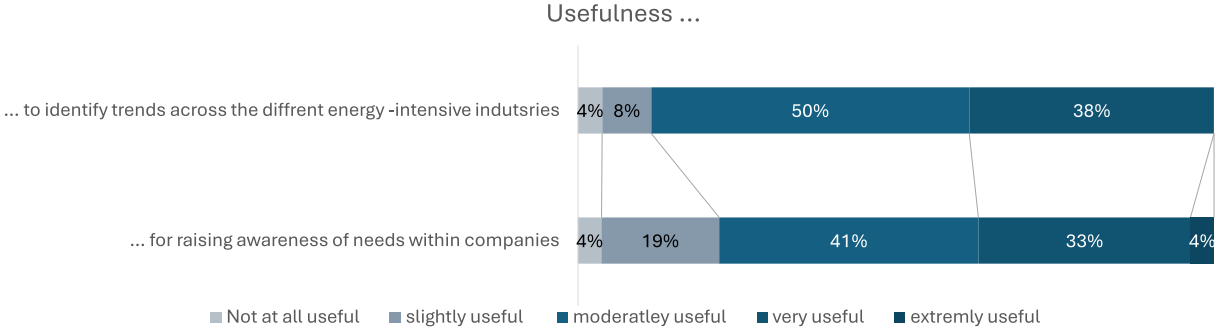


Figure 34: Usefulness of the survey, *Respondents: n=27 (raising awarenss), n=26 (identify trends)*

Considering the results and the experience of both surveys (2021 and 2024) the *Industrial Symbiosis Technology and Skills Radar* will be based on (bi-)annual questionnaires, taking up the methodological and field experience of the SPIRE-SAIS questionnaire already conducted but improving and shortening it to the main dimensions. It is foreseen to discuss the quantitative results of the Skills Radar with a number of experts, esp. from the different sectors (e.g. with the Steering Committee Sector Representatives) in workshops or a forum at the website of SPIRE-SAIS.

Additionally, the Foresight Observatory will integrate a **Project Repository,** initially designed to collect material from partners to develop the desk research on technological and economic development and skills demands. However, this repository is a good reference that will be disseminated to the whole A.SPIRE community and the interested public. The repository is organized per sector, in order to include the projects mainly based on Industrial Symbiosis and Energy Efficiency in the different sectors involved. In addition, there is a cross-sectoral project section, including projects on Industrial Symbiosis and Energy Efficiency that are transversal across the different industries. The template for collecting the projects comprises different aspects listed in Figure 35: Sectors involved, funding scheme (e.g. RFCS, Framework Programme FP6 and FP7, H2020), title and acronym of the project, main key words, start and end date, short description of the project and if the project involves either Industrial Symbiosis or Energy Efficiency (or both), what kind of flows of Energy/Material are involved, the main objectives and outcomes, the website of the project and the final report (if available). The summary description of each project has been also included in the dedicated sections of the Deliverable 2.1 (Branca et al., 2024). At the same time, forms have been updated and a dedicated folder will be created to share the repository with the interested public. It will include all forms developed for all projects, divided into sub-folders related to each involved sector. The repository will be updated continuously taken over by the Foresight Observatory beyond the project duration.

EU PROJECTS

Please fill in the tables with some details of European Projects as in the provided example:

Sectors involved	
Funding (e.g. RFCS, FP6, FP7, H2020)	
Title	
Acronym	
Key words	
Start date - End date	
Short Description:	
Industrial Symbiosis (YES or NO):	
Energy Efficiency (YES or NO):	
Energy/Material flows exchanged:	
Objectives:	
Meaningful outcomes[1]:	
Available on: URL (e.g. link to EU bookshop):	

[1]technical (e.g.by-products recycling, digitalization, etc.), regulatory (e.g. environmental legislation), economic (e.g. new business models) and social/organisational (e.g. impact on the workforce) aspects should be highlighted.

Figure 35: Project Repository (Template)

3.2 *European Industrial Symbiosis Training Framework and SKILLS4Planet Platform*

The SPIRE-SAIS Training Framework (see details in D5.1; Muract et al., 2024) outlines the structure of the training measures to address the identified skills gaps of the identified job profiles for Industrial Symbiosis and related Energy Efficiency. Against this backdrop, upskilling schemes and mechanisms for implementing tailor-made and demand-oriented trainings were created, leading to the online training platform SKILLS4Planet.

3.2.1 Upskilling schemes

To detect the best upskilling schemes a workshop with companies and training providers about training measures and upskilling schemes compared the experiences of centralised sector specific training systems such as the ESSA steelHub and the E2Driver (automotive) with other

training platforms aligning training offers to specific company and learner needs: KATCH-e (alliance of higher education institutions, companies, and research centres developing products and services for a circular and sustainable economy), CircularStart (focused on start-ups supporting incubators, trainers, and consultants in sustainability and circularity training of start-ups, ISL Industrial Training Program).

Centralised systems have the advantage of being a one-stop and an open system space that centralises and systematises existing training offers and integrating new ones, on a sustainable platform with a business model addressing specific sector needs. The challenge is to address a wide range of thematic issues, to provide the training offers and materials in different languages, and combining online and theoretical learning with on-the-job training.

The discussed **specific target group oriented systems** discussed develop target group specific modules, integrating training for trainers, show a variety of (digital) learning modalities, problem-based learning and self-learning modules to attract the learners. However, they have a project character, which leads to static and not updated results and no sustainability after the project life span, because a provider and further resources are needed

Industrial Symbiosis related training programs like the one from ISL take up the importance of addressing own thematic issues as well as adapting to the needs of companies, allowing for a fluid exchange of information and conversation with companies. Main challenge here is to address the training to the right people (which departments and profiles?).

Against this backdrop *lessons learned* and relevance for SPIRE-SAIS could be listed as such:

- A general cross-sectoral training for IS/EE and additional in-depth training topics and illustrating (sector) specific cases should be combined,
- Job profiles and levels for the training should be defined (e.g. managers, engineers, operators)
- Training should be workplace and problem based and modular structured, online and blended learning
- We need a concept that integrates companies, training providers, trainers, education systems, and the individual learner
- What about integrating additional target groups, e.g. unemployed people, teachers in CVET/IVET/HE, consultants, incubators, start-ups?
- Sustainability should be considered with the development of business models and market orientation, understanding who will be the end user (e.g. trainers, company buyers, end users directly?)

Saying this, one of the *challenges* was to find a SPIRE-SAIS solution that would be sustainable beyond the end of the project. This includes not only a sustainable operation of SPIRE-SAIS but also its rollout of training courses to the member states within the different, at least of the main languages.

Against the backdrop of the results above, an integrating training platform as a one stop and open system space (instead of standalone solutions of specific modules) was foreseen and established: SKILLS4Planet online training platform. This platform centralises and systematise existing training offers and integrates new ones, on a sustainably planned platform addressing generic and sector specific skills needs. Challenging is a wide range of thematic issues to be addressed, providing the training offers and materials in different languages, and combining online and theoretical learning with on-the-job training. Even more challenging is to ensure

updating and sustainability of the platform after the project life span via an accepted and supported business model.

In order to establish this training platform, mechanisms were created for:

- Identify skills demands, related to Industrial Symbiosis and Energy Efficiency, considering skills gaps and needs for IS and EE deployment
- Identifying and organising (cross)sectoral upskilling and/or reskilling schemes, promoting an efficient knowledge management and skills provision
- Facilitating instruments and resources that allow the implementation of measures to meet the identified skills needs.

The identification of skills demands is based on the already described job profiles (see Figure 14) and the related skills classification (see Figure 20). Against this backdrop companies could do an *inventory and comparison of skills* already in place and skills necessary to implement Industrial Symbiosis. This will give companies a sense of their *skills readiness* for IS, even if they haven't start implementing it yet.

Additionally, a broader identification of the company maturity level of Industrial Symbiosis based on the IS Readiness Levels of Sommer (2020) and adapted for a Self-Assessment Module of the CircLean project (see Figure 36) (integrated in the generic part of the trainings in SKILLS4Planet) helps to set the scheme not only for related skills demands but also for attracting companies to IS/EE measures to be taken up. The company's IS maturity level can then link to courses that will facilitate progression in that company maturity level – through the offering of specific courses for both management and operational levels as required (see Figure 14)

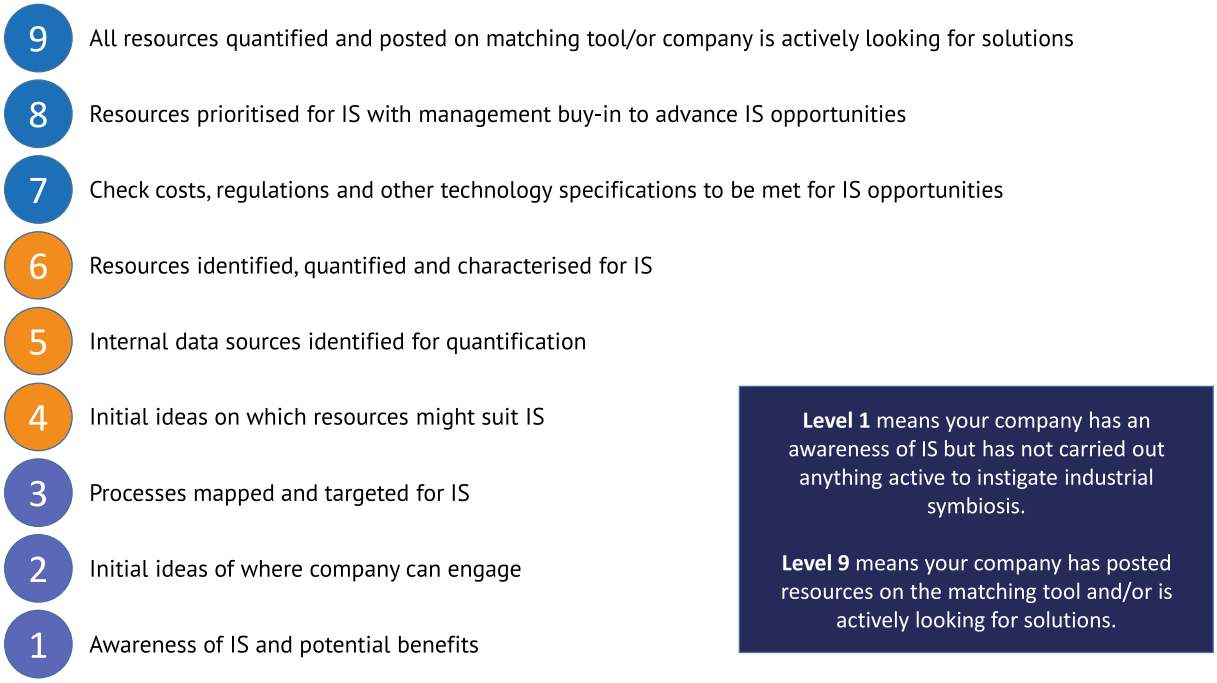


Figure 36: IS Readiness Levels *(Adapted by the CircLean projects from Sommer (2020)), study and portfolio review of the projects on Industrial Symbiosis in DG Research and Innovation: Findings and recommendations Industrial Symbiosis. European Commission)*

Based on the analysis of the training needs and already existing educational resources and training courses for IS/EE (see Table 7 and the repository in D5.1 (Muract et al., 2024) in the Annex) the SPIRE-SAIS training framework is targeted at generic training courses that impart

basic understanding and skills (such as the introduction to Industrial Symbiosis), job profile and skills topic related courses (business, regulatory, professional/technical, transversal/individual) and courses to serve the need of the various industry sectors. These trainings are collated in SKILLS4Planet consisting of (a) existing courses collected and distributed, and (b) additional courses development if relevant, not existing and capable of being developed by consortium members (especially the sector specific trainings).

DATABASE:

Case added by:	Title	Country	Area(s)	Case type (national or regional policy level /VET level / Company level)	Short description of the case (incl. the reference to the information)
ITC	GENERALITIES OF LIFE CYCLE ANALYSIS OF CERAMIC PRODUCTS	SPAIN	GREEN SKILLS	COMPANY LEVEL	This is a course requested to ITC by a VET center. The aim was to receive training in the Life Cycle Analysis methodology to be applied to the ceramic tiles it manufactures and, subsequently, to be able to prepare its own Environmental Product Declaration under the labelling programme it considers most appropriate, as well as to have the necessary information and criteria to be able to evaluate environmental improvement measures. Duration: 15 hours
ITC	ENERGY EFFICIENCY IN THE CERAMIC INDUSTRY	Spain	EE	Company Level /VET Level/Regional Policy Level	Knowing the main energy consumption that occurs in large industries ceramics, as well as being able to identify and implement the necessary measures to reduce this consumption avoiding any cross media effect (decrease of product quality). Specific bjectives: identify the points of greatest potential for savings in industrial plants, as well as the key factors that determine their analysis. Knowing energy conservation techniques and the best available technologies that support them to achieve optimum performance and reduce the consumption of industrial facilities. Addressing real cases: diagnostics energy in industrial plants. Technical-economic analysis of solutions. Duration: 20 hours
ITC	Course on LIFE CYCLE ANALYSIS CERAMIC AND	Spain	EE & IS	Company level	OBJECTIVE: This course achieves several objectives and allow companies to assess the circular benefits gained due to energy efficiency measures adopted and/or industrial symbiosis practices applied in their processes: - To study and apply in a theoretical and practical way the fundamental concepts and methodology of

Table 7: Training Database

Based on an integrated generic training module setting the scheme to manage and act for IS and EE

- thematic in-depth and advanced training courses (e.g. for an assessment of financial benefits),
- sector specifications and illustrations (ensuring the practical workplace integration and perspective),
- job profile and function related courses

are available to improve the skills and qualifications according to specific needs and interests of the learners (see Figure 37).

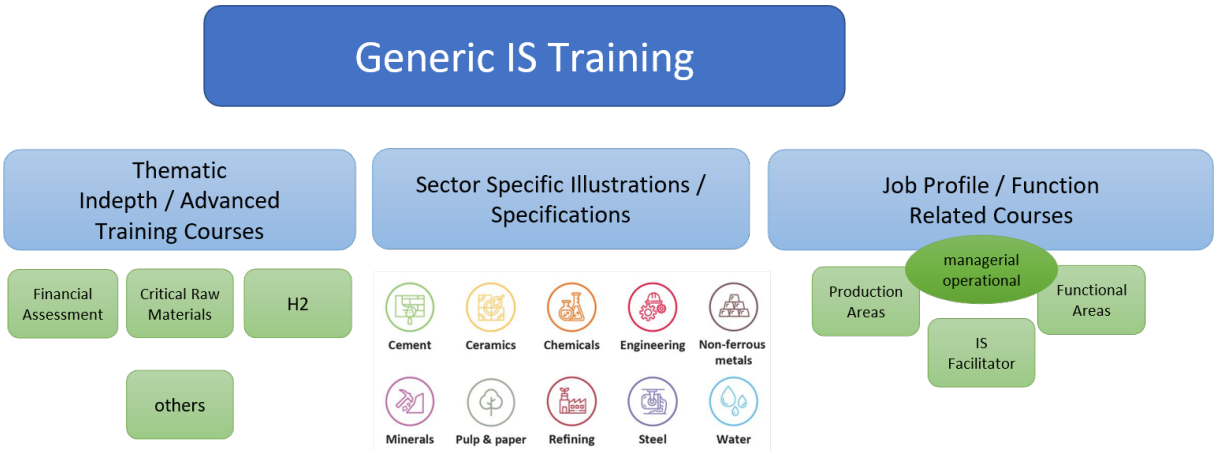


Figure 37: SPIRE-SAIS Training Framework

A connection of the online trainings to European tools (esp. the European Skills Competence Occupation ESCO Database and EQF) is given as well as to the formal national VET systems qualification offers. This is done against the basis of the VET matrix (chapter 3.3.5) to:

- Inform and enable national VET systems authorities to communicate new qualifications of Process Industry (in general) and IS (in particular). This provides a wider visibility to national VET systems' efforts towards contributing to a more sustainable society.
- Offer the possibility to pinpoint existing qualifications in formal VET systems that may help suppress the lack of skills for IS in the labour market (or even in the companies themselves). A challenge here, of course, is how to finance and address different languages.

3.2.2 Online Training Platform SKILLS4Planet

Against the backdrop of the skills adjustment approach described in chapter 3.2) SPIRE-SAIS developed the SKILLS4Planet platform (outlined in detail in D5.1; Muract et al., 2024), a centralized digital platform to facilitate communication, collaboration, and coordination. As a central element of the strategic Blueprint and being an ecosystem SKILLS4Planet sets the infrastructure for a worldwide exchange of content to create a Learning Solution Directory for the process industries. This directory is a collection of learning solutions delivered by Publishers into the framework of a marketplace business model.

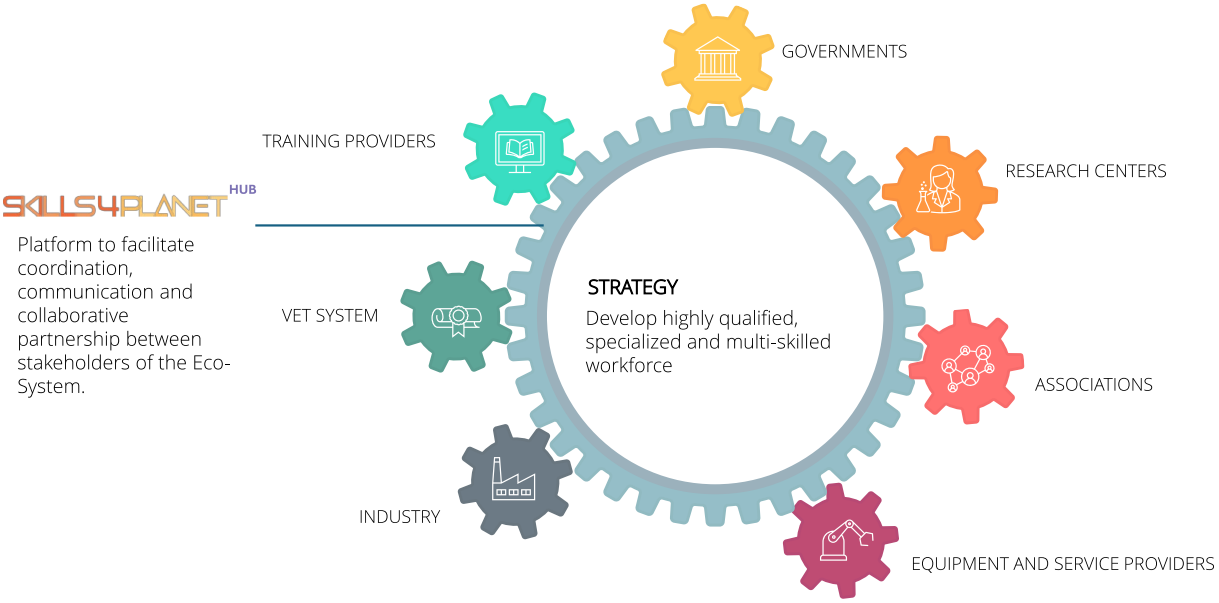


Figure 38: SKILLS4Planet Training Ecosystem

An important component of this platform is the Skill Directory, which represents the current and future training needs of the industry. This Directory is used to curate learning solutions (see examples in Figure 39). Using a standard terminology and big data infrastructure, SKILLS4Planet is able to identify skill gaps and the most in demand skills for Industrial Symbiosis to guide the training solutions development as well as analyse skills related trends that can support governments define new regulation and funding tools to support the transformation of the energy intensive industries.

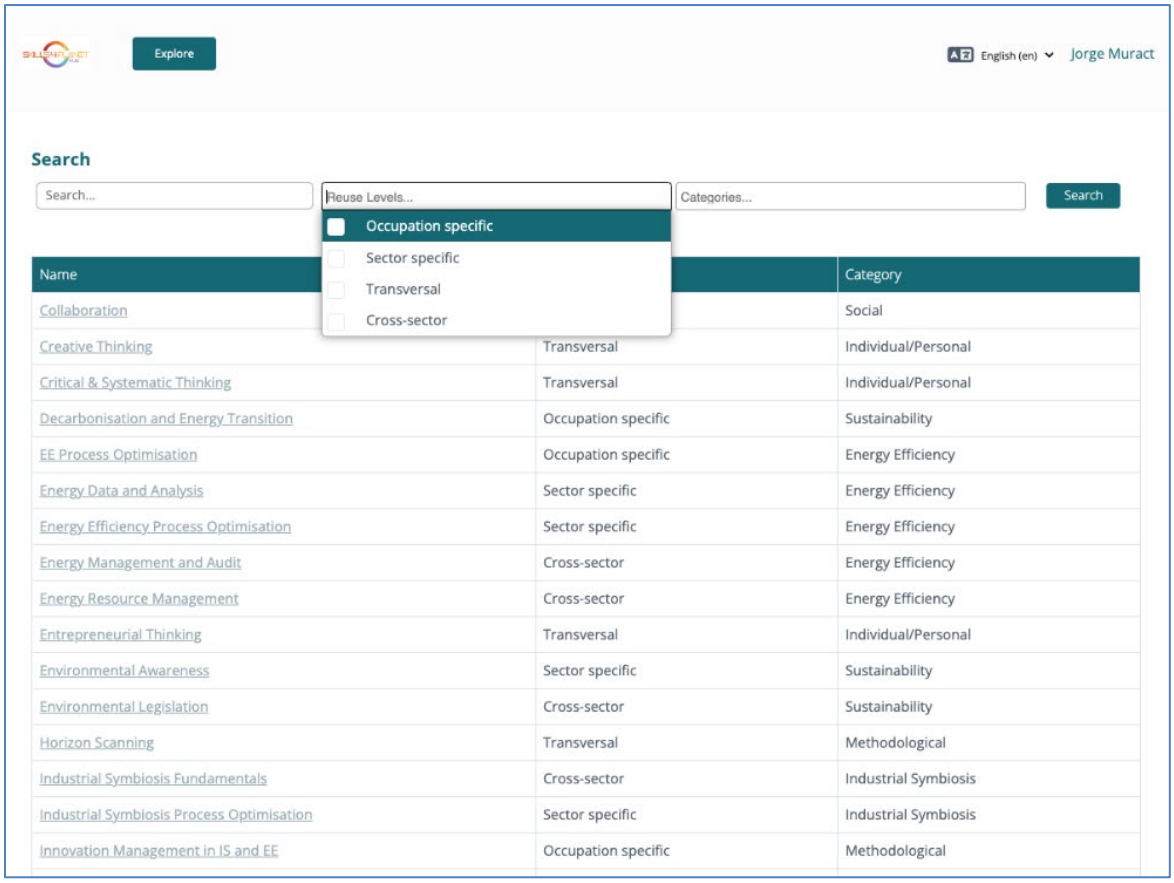


Figure 39: Skills Directory interphase into SKILLS4Planet

The integrated design of the platform offered by SKILLS4Planet enables the possibility to develop new and innovative solutions into the context of a Capability Assessor using a variety of methods to evaluate an individual's capabilities, including self-assessment, interviews, tests, and job simulations. The goal of the assessment is to determine whether an individual has the necessary skills and experience to perform effectively in each role, task or skill needed and design a custom development plan for each organisation or individuum. The following video[9] is a tutorial of the capability assessor.

The flexible integration of this platform offers organizations the ability to easily connect and integrate learning solutions with their own training systems, which can improve productivity, reduce costs, and enhance overall efficiency. Besides, regional industrial and professional associations are able to integrate these solutions to provide learning solutions to their members.

Beside the Skill Directory and the Capability Assessor a Learning Solution and Qualification Directory as well as Micro-Credentials complete the central modules characterising SKILLS4Planet (see Figure 40).

[9] https://cdn.hub.skills4planet.eu/assets/videos/play.html?id=TUT0039

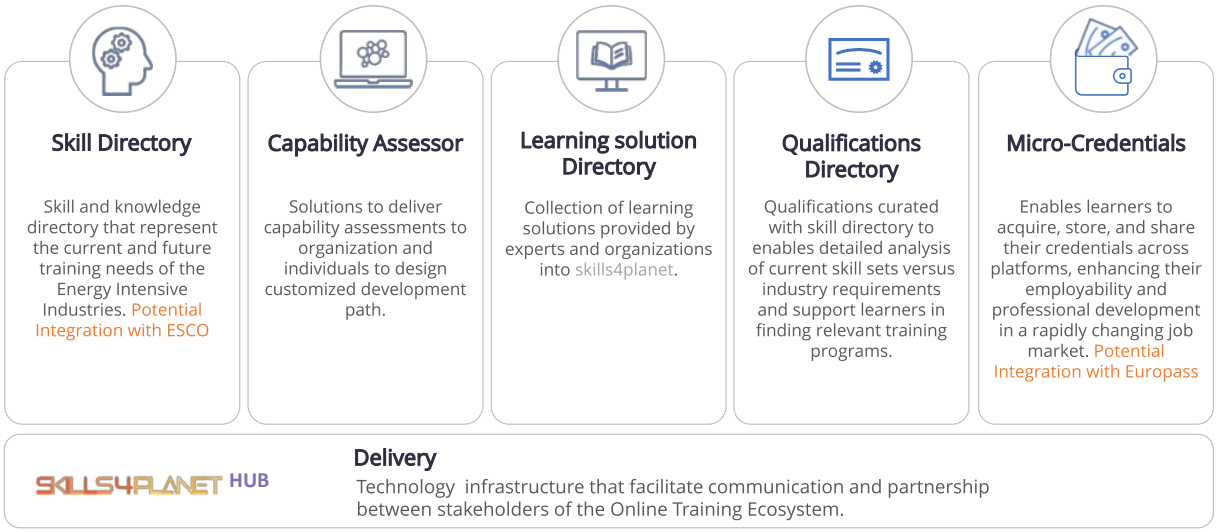


Figure 40: Modules of Digital Platform - SKILLS4Planet

Each of these modules involve tasks that have been developed during piloting and implementation phase but need to continuously executed to assure good service and quality. A description of the ongoing tasks for each pillar are:

1. **Skill Directory**[10], a centralize repository of skills and knowledge that represent the current and future training need of the different sectors.
2. **Capability Assessor**[11], solutions to deliver capability assessments to organizations and individuals for Self-Directed Learning, to support individuals take primary responsibility for planning, organizing, and executing their own learning process.
3. **Learning Solution Directory**[12]**,** which is a collection of learning solutions for up- and re-skilling current and future workforce base on publisher contribution.
4. **Qualifications Directory**[13], A Qualifications Directory is crucial for learners as it provides clarity and guidance on available qualifications, helping them make informed decisions about their educational and career paths. Besides, this directory helps to cross check learning outcomes required by the industry with formal VET programs and curricula to assure a proper alignment.
5. **Micro-Credentials**, Crucial for learners as they offer flexibility, relevance, and speed in acquiring new skills. Focused on specific, in-demand abilities, they enable learners to quickly enhance their qualifications and employability.
6. **Delivery,** flexible IT infrastructure that assure several integration options to meet the unique needs of organizations of different sizes and types as well as individuals. This includes the development of integration solutions for the following cases. Besides, this pillar includes the development and maintenance of a Dashboard with the data collected from the interaction of the learners with these pillars to support the Expert Panel in the identification of emerging skills and training needs.

To assure the continuation of the SKILLS4Planet a non-for-profit business model was put in place to assure a self-sufficient economical model (see annex of D6.2; Schröder, Götting, et

[10] https://hub.skills4planet.eu/competencemap/
[11] https://cdn.hub.skills4planet.eu/assets/app/ASMT/index.html#/assessment/intro
[12] https://hub.skills4planet.eu/catalog/
[13] https://hub.skills4planet.eu/catalog/qualifications/

al., 2024). The foreseen business model of SKILLS4Planet is based on the successful business model of the ESSA steelHub, which up to now has involved 28 companies, 8 associations, 2 equipment providers, 1 Education and training provider and 10 R&D institutes and universities. A total of 13,406 activate learners used learning solutions available in the steelHub now also available in SKILLS4Planet.

A key element for the successful implementation of SKILLS4Planet is its flexible integration using the international standard of communication (SCORM). The following diagram show how SKILLS4Planet-HUB[14] and SKILLS4Planet-LMS[15] are connecting the training offers with the different target and user groups.

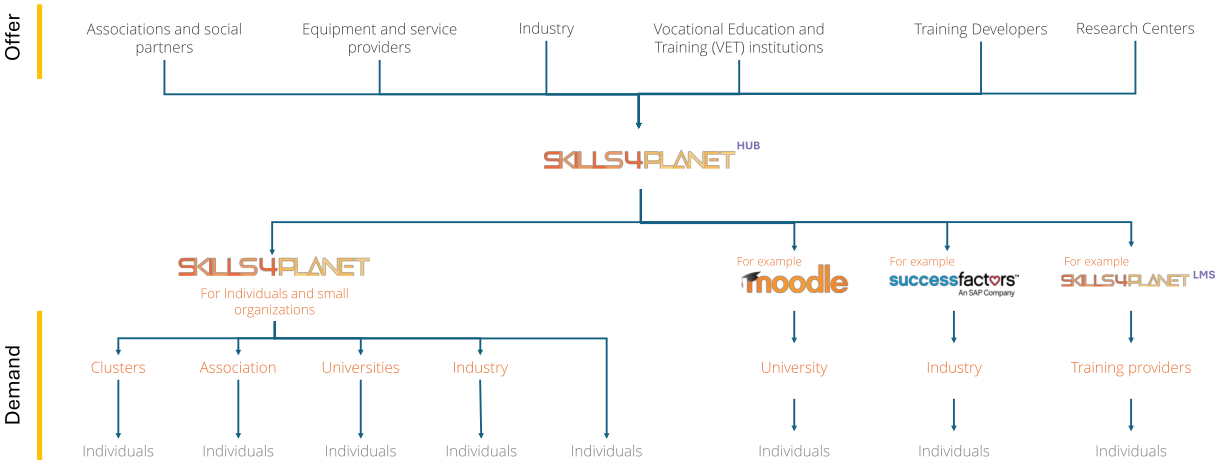


Figure 41: Information flow chart in SKILLS4Planet that connect Offer and Demand

The solutions of SKILLS4Planet can be integrated at different stages of the particular framework that companies use to develop their training programs. To have a common ground to identify key steps to improve communication and integration of SKILLS4Planet solutions, SPIRE-SAIS selected and implemented *ADDIE Model* (elmlearning, n. d.; van Vulpen, n. d.) adapted to our skills-based development program. The ADDIE model is a widely used instructional design framework that provides a systematic approach to developing effective training programs.

The ADDIE model describes a flexible, systematic process for developing training programs for adult learners. The cyclical model has five stages: Analyse, Design, Develop, Implement, and Evaluate. Each stage has a deliverable that feeds into the next stage and includes opportunities to gather feedback that informs training development. The following diagram shows how the different modules of SKILLS4Planet are integrated in this Framework, to ensure that training is well-planned, aligned with objectives, and continuously improved based on feedback and evaluation.

[14] https://hub.skills4planet.eu/
[15] https://skills4planet.eu/

Figure 42: ADDIE Model adapted to skill-based development programmes

Beside the already described Skills Directory and the Capability Assessor, the Learning Solution Directory is expanding in two keyways. Firstly, it is growing with the valuable content provided by various publishers. This publisher-provided content ensures a diverse and rich array of learning materials available to users. We get content from European Projects, trainer providers, companies, among others illustrated in the following logos.

Figure 43: Training providers SKILLS4Planet

Hydrogen oriented trainings and trainings for sector newcomers have been and will be further developed with the support of publishers (up to now for steel, ceramics, cement, minerals, water and chemical sectors). For example, American Institute of Chemical Engineers (AIChE) provide 12 courses that cover basic concepts of Hydrogen, production, storage and safety. The following image shows all the courses available in the platform.

Figure 44: Hydrogen Learning Solutions from The American Institute of Chemical Engineers.

Secondly, the directory is also incorporating content developed specifically for the SPIRE-SAIS project. These contents are tailored to meet specific educational goals and requirements of the sectors, enhancing the overall quality and relevance of the directory's offerings. Up to now there are three learning solutions developed in the project.

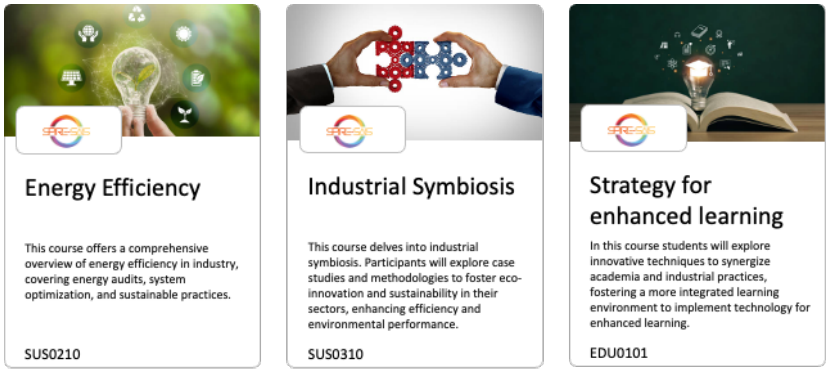


Figure 45: Learning Solutions Developed by SPIRE-SAIS project

3.3 *Image – Recruitment – Talent Management*

A much-discussed need in energy-intensive industries relates to image and recruitment. There is a high demand for skilled labour, particularly in the context of the green and digital transformation, while the industry is struggling to recruit such skilled workers. These recruitment difficulties are directly linked to the negative public perception of the industry as an old economy with unattractive, inflexible, outdated and dangerous working conditions, as well as a polluting industry.

In the course of the project, in-depth insights were gained into the current situations of individual energy-intensive sectors and regions. Not only challenges were discussed, but also possible solutions that are already being implemented in the sectors. At the same time, details of how individual regions and sectors deal with recruitment challenges were gained in the rollout workshops (see D6.2; Schröder, Götting, et al., 2024). The tools developed in SPIRE-SAIS, e.g. by connecting stakeholders through the SPIRE-SAIS Rollout and by identifying skill gaps and fostering workers' training through SKILLS4Planet, thereby facilitate the development of

recruitment measures in a sustainable manner, usable even after the project duration. In this way, SPIRE-SAIS can serve as a basis for follow-up activities in which concerted actions can be developed across different sectors of the process industry.

During the rollout workshops, the General Assembly and the dedicated workshops on image & recruiting with the involved companies, the main challenges and most in-demand jobs for Industrial Symbiosis and Energy Efficiency were discussed as well as the image and recruiting obstacles and success factors, definition and attraction of (new) target groups.

3.3.1 Main challenges and solution approaches

An important common denominator all representatives of various process industry sectors agree upon is that recruitment is one of the current main issues in the process industries. In this context, it has long been discussed that energy-intensive sectors have a *negative image* and are perceived negatively by the public. This leads to a lack of interest in working in the industry from potential applicants, including students and skilled labour. There are concerns about health and safety, combined with a critical public opinion of, for example, the steel sector, which is seen as an old and declining economy and a sector in crisis. Another example is the chemical industry, which is struggling with the image of an industry with safety problems due to accidents. In particular and across all industries of SPIRE-SAIS, there are difficulties in recruiting female graduates in the male-dominated energy-intensive sectors.

Other obstacles lie at the individual level, such as *salary levels* or *unpopular working hours and working models*, e.g. night shifts. In addition, the geographical location (as companies are often located in remote areas), the lack of political support for the process industry and an investment and innovation backlog pose major challenges for the energy-intensive sectors.

The lack of suitable applicants in general and especially in the field of Industrial Symbiosis also has a critical impact: There is a lack of specific knowledge on the part of applicants and a lack of an overview of various disciplines. This results in the *need for specific skills for Industrial Symbiosis*: on the one hand, practical experience is required, but on the other hand, an understanding of new competences (circular economy/environmental issues) is important. Companies in the individual sectors have difficulty finding graduates with such specific skills. There is also a lack of specific job profiles for Industrial Symbiosis.

To overcome these challenges, companies are doing their best, focussing mainly on *internal training and specific public campaigns.* The companies offer such specific training, as the knowledge gained at university is often insufficient and too general (especially with regard to Industrial Symbiosis) for the activities in the companies. Consequently, the job profiles for Industrial Symbiosis and Energy Efficiency are formulated holistically by the companies in order to attract people with a variety of general and specific skills. In addition, the companies promote cross-departmental work and discussions on various Industrial Symbiosis and Energy Efficiency topics.

Corporate campaigns that emphasise the importance of energy-intensive industries for public perception appear to be a promising strategy. However, these campaigns must go hand in hand with improving relations and co-operation between the energy-intensive sectors and universities/vocational training systems/secondary schools: More specific courses are needed, especially with regard to Industrial Symbiosis (see chapter 2.3, analysing the vocational training system). The image of energy-intensive industries must be improved at universities, in the vocational training system and in secondary schools. Public support is needed to improve public perception by emphasising the importance of solutions for energy-intensive industries with

regard to climate change: Industry as a solution provider and as an opportunity for (new) applicants to drive climate change.

Some success factors are:

- Salary (salary in the steel sector, for example, is higher compared to other sectors)
- Early engagement with schools, direct communication with students
- Stability and the ability to deal with crises
- Field for research to achieve climate goals
- More flexibility in balancing work and family life (e.g. home office).

3.3.2 "Most in-demand jobs" for Industrial Symbiosis and Energy Efficiency in the next 5 years

Workshops held have shown that the search for applicants in the field of Energy Efficiency appears to be less of a challenge compared to Industrial Symbiosis. As already emphasised, there is no specific job profile for Industrial Symbiosis (except the Industrial Symbiosis Facilitator, which is usually a company external job profile). However, people with Industrial Symbiosis skills need to hold senior positions to have the right access and be close to decision makers who have in-depth knowledge of the company structure. Both risk managers for operations and managers for infrastructure integration are needed. However, there needs to be a balance between (young) people with fresh ideas and staff with the right experience, as well as interaction between managers and operators at lower skill levels. The preferred solution of companies, according to the company representatives involved, is to distribute the work in Industrial Symbiosis and Energy Efficiency-related teams and thus rely on the co-operation of several people. This avoids the need for a single person to combine all these skills.

As compliance with regulations and competition laws are a barrier for companies to share information (openness, trust) regarding industrial symbioses, certain skills and competences are needed. For example, managers and employees are required to understand the extent to which organisations can share ideas and have to be able to collaborate under existing compliance agreements.

The skills to cope with and manage the green (and digital) transformation consist of hard and soft skills: technical skills (especially in STEM) are needed as a foundation, but also soft skills such as motivation, openness, adaptability and the willingness to support change. The mobility of workers must be supported by the availability of travel and in-demand language skills, as well as by improving the qualifications of applicants, which vary according to national vocational training systems.

3.3.3 Approaches and Strategies in Favour

As the *image* of energy-intensive industries is a major hurdle and challenge in recruiting talents, a more realistic image needs to be conveyed: from an outdated, old, dirty, dangerous industry towards a digital and green industry. A *new narrative* for energy intensive sectors should emphasize the efforts with regard to the digital transformation and decarbonization and the strong willingness of energy intensive sectors to become more energy efficient. As *digital and green innovative and open sectors, they are part of the societal solution for climate change*. Challenge lies in demonstrating to the public the importance of these industries, while at the same time showing that talent is urgently needed to shape future transformations. Against this backdrop, creating motivation and possibilities for (new) applicants to engage in

energy intensive sectors and to initiate change processes should be fostered. Potential applicants consequently have the opportunity in energy-intensive industries to design the *needed solutions for the future* and thereby make a positive contribution to the green transformation. Furthermore, the positive impact of energy intensive industries as important and sustainable components of social prosperity should be emphasised. In other words, *more visibility of the contribution of energy intensive sectors to a modern and green society is needed, as only with the transformation of these industries change can be brought about*. This requires a new European and national industry strategy (see German Steel Action Plan 2020 'For a strong steel industry in Germany and Europe'; Federal Ministry for Economic Affairs and Climate Action, 2020).

At the same time, working conditions should also be modernised, for example following the example of the technology and IT sector: improving work-life balance of employees, lower hierarchies, etc. (Echterhoff & Schröder, 2015). Rethinking of recruitment within the industries should, aside from higher educated people, also comprise vocational educated people, with an increase in efforts to integrate neglected target groups (e.g. female workers, migrants) with attractive training and upskilling possibilities (e.g. for migrant workers) for on-boarding and lifelong learning. Last but not least, young people's ideas and ways of thinking should also be included and considered to a greater extent. It thereby needs to be considered that ambitions, demands and mindsets of the young generation differ from the previous generations.

Against the background of IS improvement, *regional integration* is particularly important via the connections to regions by Corporate Social Responsibility (e.g.: urban IS, using cleaned water for communities, connect industrial sites and heat parts of a city with produced heat) but also by finding common solutions (e.g. pipelines for transport of heat and gas, better connections to urban infrastructure). Smart cities should integrate the value of industry’s contribution to their ecosystems.

Internships and open-door events as means to convey a realistic image of industry, also for people at a young age, are already in place and should be fostered on the regional level, where people live, learn and work. But companies could not manage the transformative change alone. Therefore, all relevant stakeholders with their own responsibilities are in charge. Improving *relationships and cooperation* of companies with universities, the VET system and secondary schools is needed, as well as public support to increase positive impact on the image of energy intensive sectors. This should lead to improved knowledge among potential applicants about industry, while also fostering a better response to industry needs by educational institutions (creating closer relations to the surrounding communities).

Against this backdrop the *lack of suitable applicants* in the field of Industrial Symbiosis should be solved by balancing (new) people with fresh ideas with experienced company staff, working in teams. However, imparting skills and knowledge internally (with a focus on in-house talents) is the most suitable and realistic way recently in order to avoid a war for talents and to retain talents in the company. This needs more specific courses, especially in the field of Industrial Symbiosis, on the job and online. In this respect, SPIRE-SAIS contributes especially with its **sector specific training for newcomers** and its other training courses to raise awareness and introduce the topics of Industrial Symbiosis and Energy Efficiency for employees in various industries.

As company structures oftentimes pose challenges, these changes need to come step by step, for the adaption of new structures and learning arrangements to succeed.

3.3.4 Further insights and examples from the sectoral and regional rollout workshops

The SPIRE-SAIS rollout related heavily to the topics of image and recruitment, discussed many times during the sectoral and regional workshops in connection with Industrial Symbiosis and Energy Efficiency. Connections were fostered during the rollout workshops between different stakeholder groups, which were able to contribute their respective perspectives and topics. Further rollout workshops could address the topic of image and recruitment even more actively and develop further solution strategies, even after the project duration. Discussion in the rollout workshops also made clear that, through the SKILLS4Planet platform, which offers training programmes focusing on Industrial Symbiosis (IS) and Energy Efficiency (EE), recruiting can also be facilitated. SKILLS4Planet thereby helps to identify skills gaps and promotes workforce development and strategic planning. By providing detailed insights into the needs of industry, especially companies, SKILLS4Planet enables a better understanding of the specific requirements of each sector, which in turn supports the recruitment of suitable candidates.

Industrial Symbiosis can have a significant impact on talent recruitment from both an employee and company perspective. For workers, Industrial Symbiosis creates a new job pool that allows for smoother movement between roles in the circular economy. This mobility can be beneficial for workers as it provides them with multiple opportunities in a sustainable and evolving sector. However, sector representatives from SPIRE-SAIS are concerned that the high turnover of staff from an industry perspective may raise concerns about investment in extensive training programmes. However, it is expected that a balance will be achieved in the long term that reconciles labour mobility with retention.

The integration of Industrial Symbiosis not only improves sustainability and competitiveness, but also emphasises the importance of regional skills development. Accordingly, sector representatives expect many important steps in talent acquisition and training to take place at the regional level. The involvement of different stakeholders is crucial, as skills are often tied to specific regions. The regional focus on Industrial Symbiosis, often associated with industrial clusters, can also help to attract talent by emphasising the benefits of a circular economy approach. The sectoral workshops show that the challenges with regard to skill needs differ regionally. For example, the Finnish chemicals sector (more specifically the battery sector) shows that there are strong skill needs and thousands of skilled workers are required, which are currently missing from the Finnish labour market. Meanwhile, the situation in the Italian Emilia-Romagna region is different - there are enough qualified workers and good training opportunities, but the chemical sector here is in a process of change, from classic chemical production to more sustainability, which currently leads to challenges in the sector; as a result, many people in the region are losing their jobs. The current regional situation in Emilia-Romagna and missing job offers tends to cause qualified workers to migrate to other regions and countries.

A crucial aspect of labour force development is the focus on education and training. While attracting talent is the first step, continuously improving skills ensures that the workforce remains competent and can adapt to changes in the industry. However, despite its potential benefits, Industrial Symbiosis is often perceived as complex and difficult to explain. The concept has various definitions, which makes it less attractive. To counteract this, emphasising positive terms such as sustainability, greening and modernisation can help to better communicate the benefits.

It is fundamentally important to emphasise the clear benefits of Industrial Symbiosis. It pushes the boundaries of collaboration between industrial neighbours, offers site-level solutions and

connects different sectors. This collaborative potential can be a compelling aspect for industry to work towards common goals, making Industrial Symbiosis an attractive proposition despite its inherent complexity.

When asked whether it is more difficult to attract workers to traditional or green jobs, sector representatives give a nuanced answer. Greener jobs tend to be more attractive as the focus is increasingly on sustainability. However, it is crucial to communicate that the green transition will bring changes in job roles. Clear explanations and a focus on upskilling and reskilling are crucial to prepare the workforce for these changes. Rather than just differentiating between green and traditional jobs, it makes more sense to discuss the overall transformation of the industry and the opportunities it presents.

3.3.5 Summary

While recruiting skilled workers for energy-intensive industries is a challenge, tools such as the SKILLS4Planet platform and the SPIRE-SAIS rollout offer valuable solutions. By addressing skills gaps, fostering sectoral, national and especially regional collaboration and focusing on continuous workforce development, these efforts can improve talent attraction and retention and ultimately contribute to a more sustainable and competitive industry. The rollout workshops have further underlined the efforts to improve the image of energy-intensive sectors and at the same time show that real change processes are underway in the various sectors and regions. Efforts must continue to improve the perception of energy-intensive industries among young, qualified applicants. In particular, the green and digital efforts of the sectors should be highlighted in order to break away from the status of the old economy. Transformation processes are also taking place with regard to working conditions - away from hard, dirty, hazardous work towards a more modern way of working and better integration of disadvantaged labour market groups.

The rollout workshops have also shown that the individual sectors are pursuing specific, sector-coordinated measures on image and recruitment. Although most of this is primarily happening at company level, sector-specific dialogue is taking place in various working groups. In the steel sector, ESTEP's Focus Group People should be emphasised in particular, where measures relating to image and recruitment are also discussed with the members. The water rollout has shown that there is also a working group in the water sector that deals with human capital and therefore also with recruitment issues. The sector associations, which create important connections, are particularly valuable partners. The SPIRE-SAIS project and the rollout have created further connections and networks between stakeholders within the sectors and regions and strengthened structures that can facilitate communication and cooperation even after the project has ended. However, a major challenge of SPIRE-SAIS was to achieve concerted action across all sectors represented in the project. This long-term and demanding task remains open for follow-up projects.

4 The Coordination Side: European Open Coordination Integrated in Existing EU Structures

As stated by the European Skills Panorama: "Skills Intelligence is the outcome of an **expert-driven process** of **identifying, analysing, synthesising and presenting** quantitative and/or qualitative skills and labour market information [...] kept up-to-date and adjusted when user needs change. This requires the expert-driven process to be continuous and iterative"

(Cedefop, 2019). This is exactly the approach of SPIRE-SAIS, starting already in the proposal phase to accelerate such an expert-driven process by integrating different stakeholder groups of energy intensive industries in a multi-stakeholder and ecosystem approach (quadruple helix: industry, policy, research and education, civil society).

The consortium and associated partners of SPIRE-SAIS bring together the **full range of stakeholders** required to establish a sustainable cross-sectoral strategic Skills Alliance, covering all SPIRE sectors and scoping directly twelve member states from Northern, Eastern, Western and Southern Europe. However, via its sector associations, the Alliance covers all the European Member States with Energy Intensive Industries. This ensures a Europe-wide rollout of the SPIRE-SAIS Blueprint engaging with national VET systems and cross-sector European frameworks to meet skill needs. The partnership includes key industrial associations of all engaged sectors (Chemicals, Steel, Minerals, Non-ferrous Metals, Water, Engineering, Ceramics, Cement, Refinery, Pulp & Paper), and key actors (companies, training providers and research institutions) involved in actual and forthcoming projects of Industrial Symbiosis, Energy Efficiency and VET (skills and qualification needs and solutions). The partnership (consortium and associated partners) is based on and feeds the HORIZON 2020 Public Private Partnership A.SPIRE with more than 170 members (companies, training providers, research institutes) encompassing and being the co-leader of SPIRE-SAIS.

Within this partnership we see *skills as a missing link for Industrial Symbiosis of the different sectors, open up a common ground for collaboration beyond competitiveness, and unfold the potential of new technologies and measures for Industrial Symbiosis and Energy Efficiency at the company workplace, closely interlinked with the workplaces of other companies.*

4.1 *Integration, Alignment, Cooperation of SPIRE-SAIS with European Structures*

The SPIRE-SAIS Blueprint is not planned as a stand-alone solution. The Blueprint strategy is led by a cooperative approach with a division of responsibilities and leadership. Therefore, the Foresight Observatory, SKILLS4Planet and the European IS Training Community are aligned with and are supporting European activities related to European Energy Intensive Industries (see Figure 46), namely:

- Sustainable Process Industry through Resource and Energy Efficiency (A.SPIRE) and its recent activities, explicitly "Processes for Planet" (P4Planet), its Strategic Research and Innovation Agenda 2050, and its governance structures and working groups
- The Coordinated Support Action “European Community of Practice for Industrial-Urban Symbiosis and Regional Hubs for Circularity and Industrial Urban Symbiosis”
- Central stakeholder groups (social partners, sector associations and unions, policy-makers, education system players, etc.)
- European networks and projects: e.g. the CircLean Network and Circle Economy, the INSIGHT project results for establishing the profile/occupation of the IS Facilitator
- European programs: European Pact for Skills and here especially the LSP Energy Intensive Industries; CEDEFOP Skills Intelligence Platform; European Skills, Competence, and Occupation Database (ESCO)

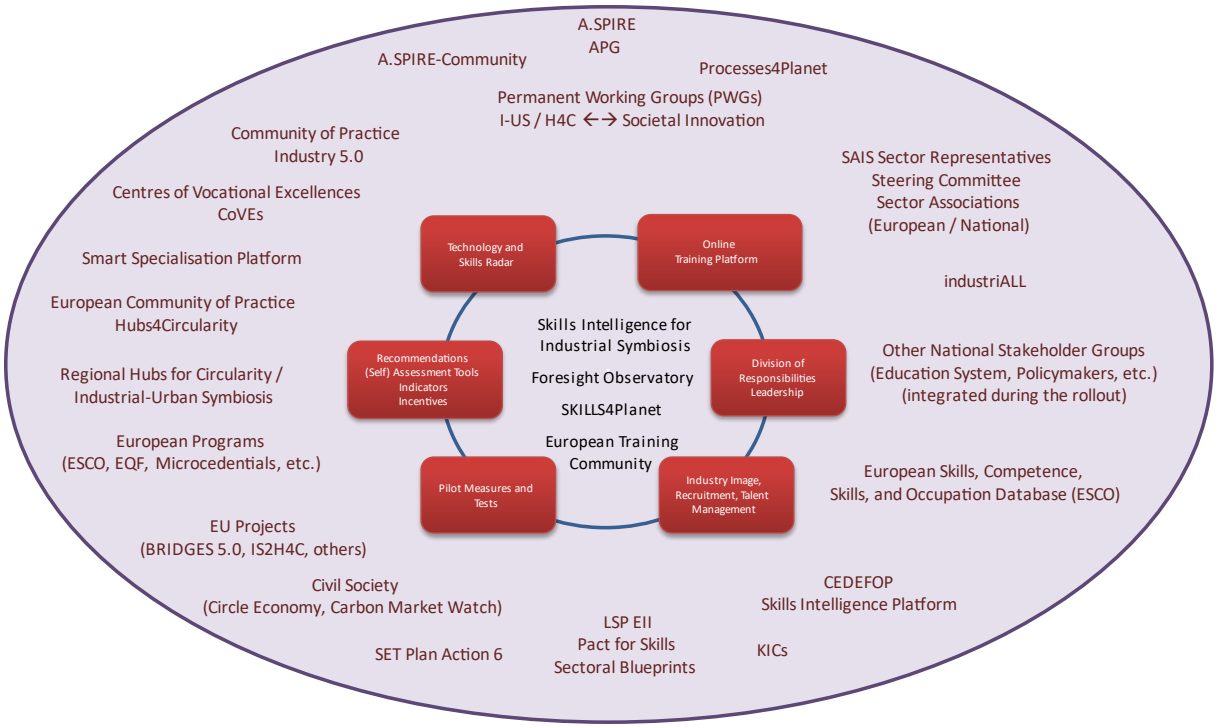


Figure 46: Integration SPIRE-SAIS in European Activities on Energy Efficiency and Industrial Symbiosis

4.1.1 A.SPIRE / Process for Planet

As being central coordination elements of SPIRE-SAIS, the **Foresight Observatory**, SKILLS4Planet online platform and the European Training Community have to be aligned with the program and governance structure of the A.SPIRE and the Processes for Planet program (P4Planet) with its Strategic Research and Innovation Agenda 2050 (SRIA). As SPIRE-SAIS partners are closely integrated in the development of the A.SPIRE community and P4Planet the SRIA, non-technological and social issues were successfully and explicitly integrated in the P4Planet program, placing prominently non-technological issues for improving technology development and competitiveness (esp. through human resources and skills and human-centricity of the Industry 5.0 concept). The agenda foresees to align almost every technological innovation program with non-technological issues (with related investments in a range of 1% to 5% of the project budget) and, additionally, to set up an own innovation program for Human Resources (aiming at a funding of about 42 million Euro from 2020 – 2050).

Within the new advisory and programming structure SPIRE-SAIS is aligned very closely with two Permanent Working Groups (PWG) (see Figure 47):

- the PWG Industrial Urban Symbiosis and Hubs for Circularity (I-US/H4Cs) and
- the PWG Societal Innovation (skills, jobs, training).

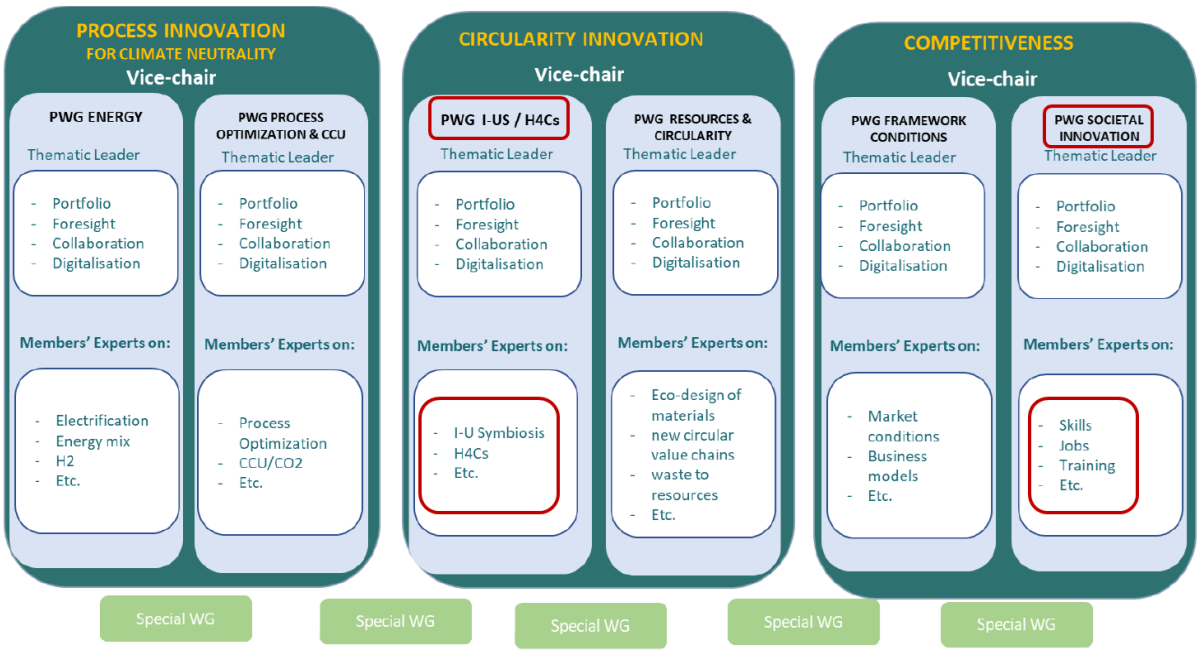


Figure 47: Planned Working Groups of the Advisory and Programming Group of P4Planet

Ensuring a reliable cross-sector representation, SPIRE-SAIS established a "**Sector Representative Steering Committee**" (see Table 8) as a link to the different SPIRE sectors, including also the unions and civil society perspective. This important link to combine the cross-sectoral with the sector specific necessities and demands is a mutual exchange platform for feeding the sectors with SPIRE-SAIS results, measures and tools on the one hand, on the other hand giving feedback and inputs from the sectors to improve the SPIRE-SAIS Blueprint, training platform and rollout

Sector	Partner	Function	Organisation
SAIS Coordination	TUDO	Coordinator	Research
SPIRE	A.SPIRE	Co-coordinator	SPIRE Coordination
Non-ferrous Metals Aluminium	EU	Sector Representative	Aluminium, EU Association
Ceramics	Ceram-Unie	Sector Representative	Ceramics, EU Association
Minerals	IMA	Sector Representative	Minerals, EU Association
Chemicals	ECEG	EU Employers Representative	Chemicals, EU Employers Association
Water	Water Europe (WE)	Sector Representative	Water, EU Association
Cement	CEMBUREAU	Sector Representative	Cement, EU Association (associated partner)
Engineering	SSSA	Sector Representative	Engineering (partner)
Pulp & Paper	CEPI	Sector Representative	Pulp & Paper, EU Association (yet not formally participating, but invited as a visitor)
Refinery	Concawe	Sector Representative	Refinery, EU Association
Raw Materials	EIT RawMaterials	Sector Representative	EU EIT (associated partner)
ESTEP	ESTEP	Sector Representative	Steel, EU Association (partner)
EUROFER	EUROFER	Sector Representative	Steel, EU Association
Union	industriALL	Representative Unions	(Global / European) Union (associated partner)
NGO	Carbon Market Watch	Citizen Organisation	Global NGO (associated partner)

Table 8: Steering Committee Sector Representatives

4.1.2 European Community of Practice on Industrial Urban Symbiosis / Regional Hubs for Circularity

To connect SPIRE-SAIS much better with the national-regional level, we are focusing on a European-regional rollout strategy. In addition to the European alignment with the P4Planet activities and coordination structures, especially the SKILLS4PlanetTraining Platform should feed in regional activities like the European Community of Practice of Industrial Hubs for Circularity. With this and other European-regional platforms (e.g. Centres of Vocational Excellence, Smart Specialisation Regions), SPIRE-SAIS could foster IS training and skills development with regional actors. Additionally, we could enhance regional development by supporting a social innovation process of technological, economic, and social development: providing and establishing not only online and on the job training frameworks for Industrial Symbiosis and Energy Efficiency, but also skills and competences for enabling and facilitating cross-sectoral Industrial Symbiosis by integrating stakeholders from the quadruple helix (industry, policy, research and education, civil society), improving acceptance and societal and symbiosis readiness level in the regions by ensuring tailor-made and pro-active adjustment of industry driven skills demands.

Against this backdrop, SPIRE-SAIS is aiming at establishing a European Training Community of Practice (ECoP) connecting regional training ecosystems for IS and EE (including public authorities and policy, big companies and SMEs, social partners, educational organisations and training providers, as well as civil society (organisations)).Via the ECoP a connection and

networking of Industrial Symbiosis regions, not only exchanging tools and knowledge across regions but also mutual learning, not reinventing the wheel several times new.

Together with the ECoP, suitable European regions for the SPIRE-SAIS Blueprint and Training Platform rollout could be identified reaching high Symbiosis Readiness Levels (SRL) also based on skills, competences and qualifications. Within a comprehensive concept, an interplay between actors from different industry sectors at local, regional, national, and European level is aimed at. Common stakeholder workshops at the regional level combining and improving technological and social readiness will set new impulses, creating new industrial opportunities and overcome (social) challenges, by new learning arrangements for solving technical and non-technical problems and improving the capabilities of the enablers/facilitators of Industrial Symbiosis and Energy Efficiency.

4.1.3 Stakeholder Groups

Sector Associations and unions (namely industriALL Europe) are involved in SPIRE-SAIS as (associated and full) partners and through the "Sector Representatives Steering Committee" (see Table 8) as the *central connection nodes* and links to the ten SPIRE sectors: Chemicals, Steel, Minerals, Aluminium, Water, Engineering, Ceramics, Cement, Refinery, Pulp & Paper. Through their membership they connect the SAIS Blueprint not only with the different sectors on the European level but also with the national level. As such, they are the main actors for the rollout also to the Member States. This especially includes industriALL as a European union, representing different sectorial and national trade unions of the member states. Additionally, other (national) stakeholder groups (policymakers, education system players, public authorities etc.) were integrated during the rollout of the Blueprint.

4.1.4 European Networks and Projects

SPIRE-SAIS became not only an approved partner of the European Pact for Skills, a flagship initiative of the European Skills Agenda. Furthermore, in May 2023 as part of the European Year of Skills the **Large Scale Partnership Energy Intensive Industries (LSP EII)** was launched based on the two Blueprints ESSA and SPIRE-SAIS. So far, the more than 40 signatories encompass new members and sectors:

- Steel, Minerals, Water, Engineering, Logistics, Non-Ferrous Metals (Aluminum), Ceramics, RawMaterials, Welding, Chemicals, Cement, Refinery
- 8 companies (also training providers), 12 industry associations, 1 union, 1 industry park, 6 training providers, 13 consultancies and research institutions (most of them are also training providers).

With this LSP EII SPIRE-SAIS will support the Pact for Skills by establishing alliances of energy intensive industries for a green and digital transition, on a European, national, local and regional level. Additionally, by participating in the Pact for Skills we were successful to integrate new partners and sectors. As being the only multi-sectoral Blueprint, SPIRE-SAIS is not only strongly contributing to the New Skills Agenda and the Pact for Skills, but also to the “Twin transformation: digital and green” of the European Commission. It fosters an integration and further development of ESCO from a green skills perspective of Industrial Symbiosis. Beside the cooperation with other blueprints SPIRE-SAIS is contributing with the integration of human resources (skills) needs in further European programmes (such as Processes for Planet, SET Plan Action 6, Clean Steel Partnership, Vocational Excellence, Smart Specialisation).

As stressed in the cooperation plan, SPIRE-SAIS cooperates closely with other process industry related blueprints (esp. automotive, steel, advanced manufacturing, batteries, hydrogen). As steel is one of the energy intensive industry sectors, we collaborate esp. with the European Steel Skills Alliance (ESSA), and the Clean Steel Partnership (CSP), where skills are part of the building block "Enablers" (see CSP Roadmap). Additionally, SPIRE-SAIS is reported in the annual sector association meetings, collaborating also with specific sector programs on skills (e.g. in the water sector with the European Junior Water Program, explicitly made to attract talented young people).

Not to forget that SPIRE-SAIS is based on the analysis of recently more than 200 EE and IS related EU (past and ongoing) funded projects (such as MAESTRI, COPRO, SHAREBOX, EPOS, SPRING, see Deliverable D2.1). A repository is under construction to be published at the SPIRE-SAIS homepage, and will be continuously being updated.

The Blueprint is connected closely via associated partnership and taking advantage of EE and IS skills related networks (like CircLean, SUSTAIN and the Circular Jobs Initiative of Circle Economy) and projects (like the INSIGHT project). CircLean has inspired our networking activities with its training program and INSIGHT results were used for establishing the profile/occupation of the IS Facilitator as part of our training platform SKILLS4Planet.

During the rollout phase of SPIRE-SAIS the knowledge platform of the ECoP H4C was enriched by our results. Cooperation with other European or sector specific platforms are foreseen, e.g. with the European Cluster Collaboration Platform and their sector related clusters (e.g. steel, ceramics, water or engineering as well as Centres of Vocational Excellence (CoVEs) relevant for Energy Intensive Industries.

4.1.5 European Programs, Initiatives and Tools

European skills related programs are of utmost importance for SPIRE-SAIS, esp. the European Pact for Skills, CEDEFOP Skills Intelligence Platform, and the European Skills, Competence, and Occupation Database (ESCO). The SPIRE-SAIS training platform SKILLS4Planet uses and integrates EU instruments and tools related to skills and occupations such as ESCO, EQF, and EQAVET as much as possible. Linking industry related skills and job profiles with learning outcomes we aligned our trainings also with qualifications, promoting mobility of workers within the European territory. Quality assurance principles as well as instruments and indicators of EQAVET are considered in the evaluation framework setting of the SPIRE-SAIS Blueprint, thus promoting the alignment of the SPIRE-SAIS evaluation strategy with EQAVET practices (as part of Deliverable 8.1, chapter 7). The SKILLS4Planet platform (see Deliverable D5.1) is aligned as much as possible with European and national VET structures, utilising available classifications from ISCO/ESCO to classify and inform understandings of job roles and skill content. Meetings with ESCO representatives took and will take place based on the outlines of the job profiles and occupations and their alignment with the ESCO database. European initiatives like the Circular Cities and Regions Initiative (CCRI) and the European Circular Economy Stakeholder Panel (ECESP) are informed by SPIRE-SAIS results and activities. First inputs were made to the Strategic Energy Technology (SET) Plan, recognising within its Action 6 non-technological issues (incl. skills) as important part for a successful innovation policy and considering to set-up a task force for this topic. Horizon Europe proposals for Processes4Planet, Clean Steel and HORIZON Europe cluster 4, 5, 6 are inspired by SPIRE-SAIS partners and results continuously. New projects (namely BRIDGES 5.0, IS2H4C) and networks (e.g. the Community of Practice Industry 5.0) are inspired and conducted by SPIRE-SAIS partners as well.

4.2 *Alliances and Leadership*

The basis for the sustainable alliance and leadership of SPIRE-SAIS is the project partnership and the support of the existing A.SPIRE coordination. Already in its proposal phase, with a cross-sectoral approach covering all the energy intensive industry sectors, SPIRE-SAIS was already composed by main European stakeholders, integrating companies, education and training providers, associations and social partners, and research institutions of the energy intensive industry sectors. The Skills Alliance on Industrial Symbiosis is based on the European Level by 24 Industrial Symbiosis experienced partners, enhanced by a growing number of associated partners (13 up to now) showing the great attention and relevance of this alliance and leading to a sound ground for sustainability already since the start of the SPIRE-SAIS project (see Figure 48). A strong integration into the A.SPIRE Community, the Processes for Planet program and activities as well as the participation of the European Sector Associations as central communication and dissemination intersections, reinforced by their participation in the Steering Committee Sector Representatives, are continuously improving the ground for the sustainability of the Skills Alliance beyond the project duration.

Via its partnership SPIRE-SAIS is already an ongoing topic of the sector associations on the European level: e.g. A.SPIRE/P4Planet (Permanent Working Group Societal Innovation), European Steel Technology Platform ESTEP (Focus Group People), and the regular meetings of the involved sector associations (Industrial Minerals Association Europe (IMA), European Aluminum, European Chemical Employers Group (ECEG), EIT RawMaterials, Water Europe, Cerame-Unie, and CEMBUREAU The European Cement Association). Beside the employers' associations the European union industriALL is an important partner ensuring the workforce perspective and transfer to the different trade unions of the sectors and member states.

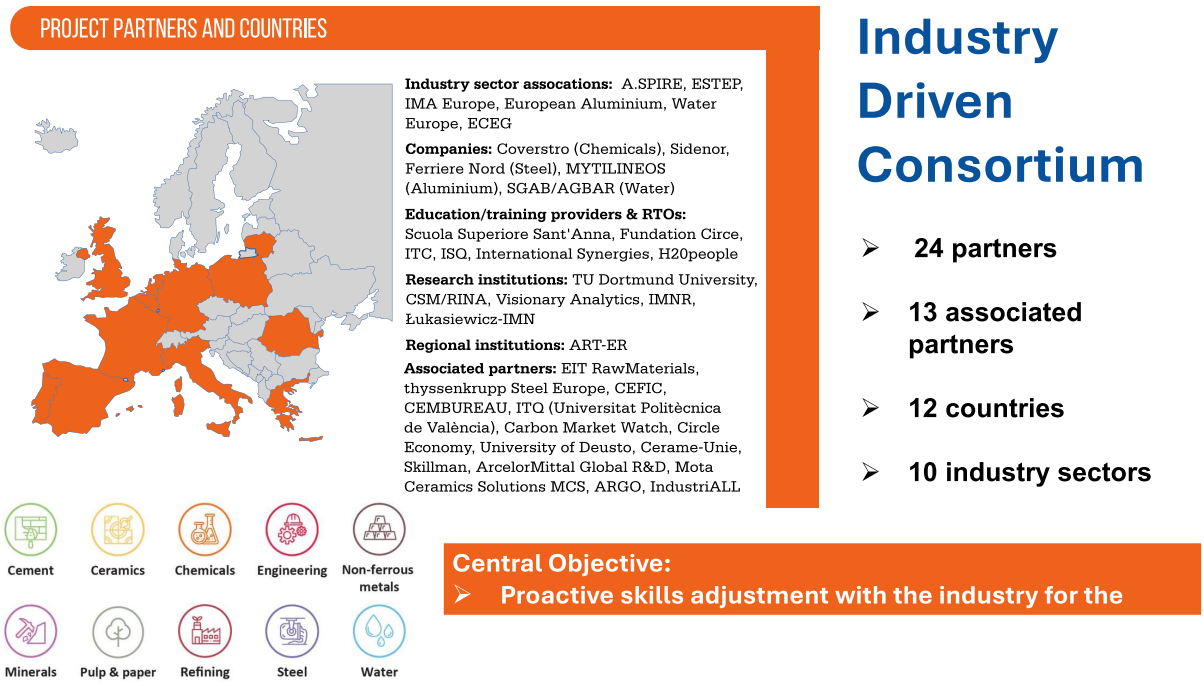


Figure 48: SPIRE-SAIS Partnership

To establish a sustainable European Skills Alliance for Industrial Symbiosis beyond the project life span with a reliable leadership and governance on the European level we systematically linked the European Blueprint as much as possible with the European, national, and the regional level. Therefore, SPIRE-SAIS is aligned with and supporting already existing European

structures of energy intensive industries. Overall activities and initiatives of the European energy intensive industries are linked to our project by participating in regular A.SPIRE and P4Planet activities and events. Via A.SPIRE (the SPIRE-SAIS co-coordinator and the coordination unit of the public-private partnership P4Planet under Horizon Europe) and its main coordination activities (e.g. Strategic Innovation and Research Roadmap 2050, call development, General Assemblies, Workshops like Hubs4Circularity) almost all partners are involved in these activities, not at least because they are members of A.SPIRE.

On the **sectoral level** and reaching the **member states,** the involved associations have informed their members in multiple occasions, via their information channels, state of affairs and also (sometimes recurring) webinars. The associations referred to SPIRE-SAIS in presentations: E.g. IMA during an EIT-RawMaterials event addressing the brain drain and the various experiences at company or at sector level that aim to address the needs and obtain a high workforce retain rate in the sector; ESTEP via its FG People, and Cerame-Unie by establishing a Skills Working Group are mirroring continuously the SAIS development. Close cooperation took and takes place with ESTEP and the ESSA Blueprint (European Steel Skills Agenda and Alliance), presenting the SPIRE-SAIS Blueprint in the regular meetings and external events. In all the activities the innovative approach of SPIRE-SAIS was very much appreciated and acknowledged.

Furthermore, the SPIRE-SAIS and ESSA approach were the starting point to think about a Task Force Non-Technological Innovation within the SET Plan Action 6. Additionally, presentations or panel participations within the Circular Economy Stakeholder Conference, the European Innovation Days, Vocational Skills Week, Citizen Engagement Festival, European Year of Skills, and the cooperation with Circular Economy Initiative (advisory board, discussion papers) show the high engagement of SPIRE-SAIS also outside the energy intensive industry sectors.

As already outlined in the beginning of this chapter (see Figure 32) the Skills Alliance will be run by the Foresight Observatory, the SKILLS4Planet platform and the related European Training Community. Therefore, SPIRE-SAIS is aligned with the main European coordination units:

- European: Via A.SPIRE to The Sustainable Process Industry through Resource and Energy Efficiency (SPIRE) and its recent activities, namely Processes for Planet (P4Planet) (see A.SPIRE, 2021), and its governance structures and working groups (esp. the Permanent Working Groups Societal Innovation and I-US/H4C)
- Sector/National: Via the Steering Committee Sector Representatives to the European sector associations of all ten sectors involved: Industrial Minerals Association Europe (IMA), European Aluminium, European Chemical Employers Group (ECEG), EIT RawMaterials, Water Europe, Cerame-Unie, CEMBUREAU European Cement Association, ESTEP/EUROFER, European Petroleum Refiners Association Concawe, Confederation of European Paper Industries CEPI.
- Regional: Via the European Community of Practice for Industrial-Urban Symbiosis with the Regional Hubs for Circularity and Industrial Urban Symbiosis, completed by involved regional associations and platforms (such as ART-ER and ARGO)
- Multi-sectorial: Via the LSP EII and the European Pact for Skills to the broader community of different sectors and other sectoral Blueprints
- Social Partnership: Via the sector associations and industriALL to the different industry sectors and member states and related institutions (e.g. the Sectoral Social Dialogue Committee on Steel).

This coordination structure (see an illustration in Figure 49) will be further developed with relevant stakeholders and leaders beyond the project life span. Objective is a deep and mutual involvement of SPIRE-SAIS in the European, national and regional sector governance and activities, in both directions: informing the different sectors by SPIRE-SAIS results, tools and activities and informing SPIRE-SAIS by recent sector activities on Industrial Symbiosis on the European, sectorial, national, and regional level. Within these governance structures cross-stakeholder activities are initiated and launched, as well as internal integration of skills adjustment within the activities of the associations, unions, companies, and training providers.

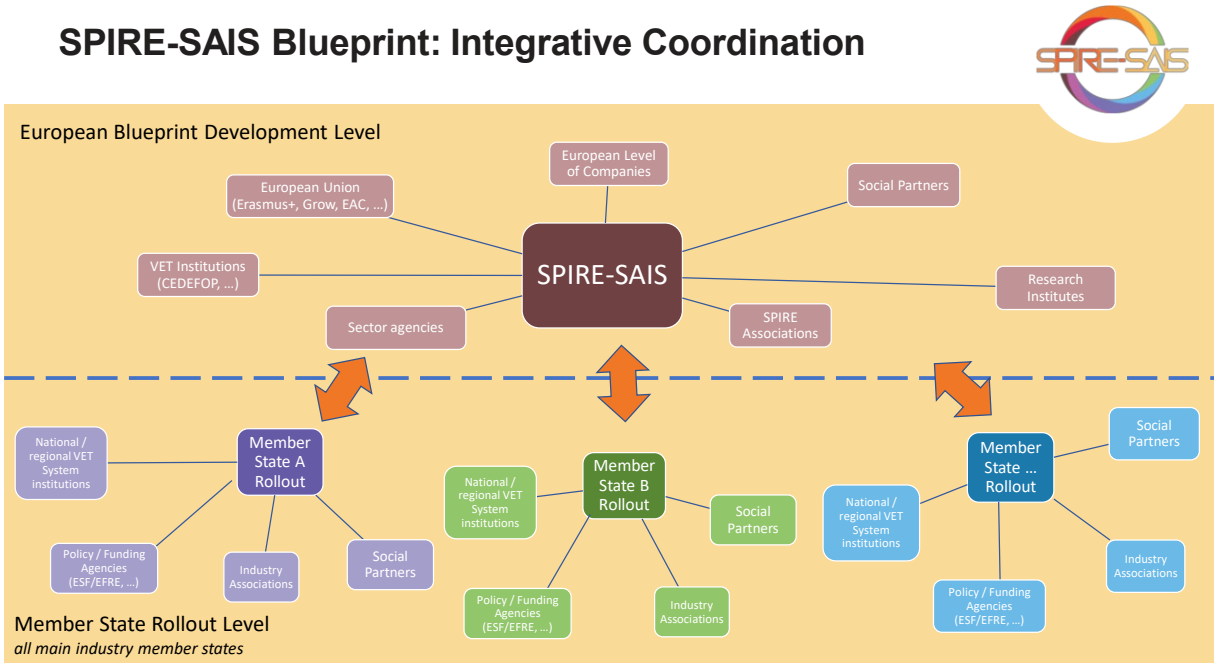


Figure 49: European sectoral-national Coordination of SPIRE-SAIS

5 Implementation and Rollout

As already becoming evident in the SPIRE-SAIS Alliances and Leadership approach, the rollout of the Blueprint is a continuous part of the partnership activities, being European, sectoral related, national and regional (see the approach illustrated in Figure 50). Applying the well-known European Open Coordination method, SPIRE-SAIS coordinates the skills adjustment via its Foresight Observatory and Training Platform SKILLS4Planet on the European level in cooperation and alignment with the A.SPIRE community. Additionally, the rollout of the Blueprint at the sectoral and national level is mainly advised by the different sector associations (SPIRE-SAIS Steering Committee Sector Representatives) and the involved partnerships. SPIRE-SAIS is engaging the sector associations as nodes to the (national) members of their specific sectors (Chemical, Water, Ceramics, Raw Materials, Cement, Aluminium, Minerals, Engineering, Refinery, Pulp and Paper). In this way, important companies and training providers of these sectors are already informing their plants, partners and contacts about SPIRE-SAIS measures, trainings, and tools, as well as about the Pact for Skills and other sectoral blueprints involving public VET and higher education authorities.

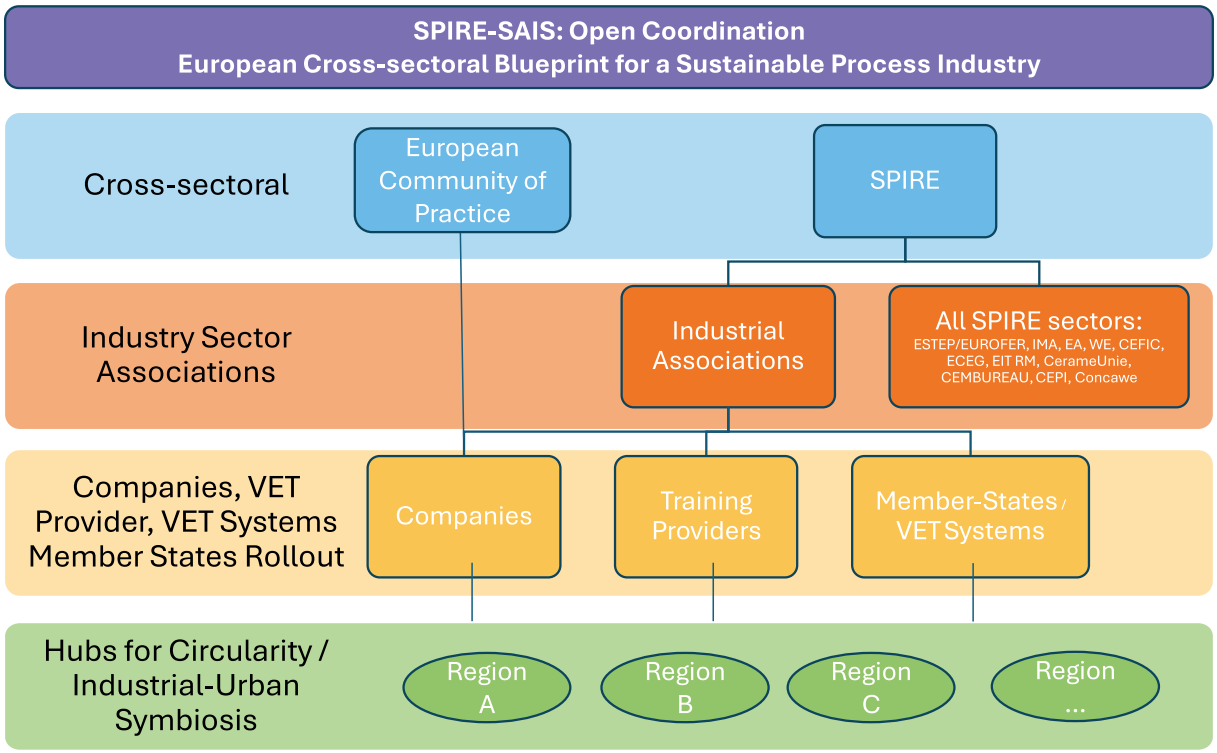


Figure 50: European-sectoral-national-regional Rollout with Open Coordination

As said, rollout (and dissemination) activities were already done by the partnership since the project started and run through the whole project life cycle and beyond to ensure relevant, applicable, visible and detailed results. A dissemination and communication plan with SMART (Specific, Measurable, Achievable, Realistic and Time-bound) objectives was implemented and aligned with the European Quality Assurance Reference Framework for VET (EQAVET); annually monitored and evaluated by the (internal) project evaluator. Monitoring and evaluation of the project is guided and conducted by the Monitoring Strategy and Evaluation Plan (D8.1; Almeida & all WP leaders, 2020) and Annual Evaluation Reports (see D8.2; Almeida, 2020, 2022a, 2022b, 2024). With these instruments we are able to demonstrate how effectively the project is reaching its objectives, while getting closer to its desired outcomes. Above that, these instruments allow us to tackle the shortages and weak points identified by partners to be improved (SPIRE-SAIS as a social innovation process, see Figure 3).

5.1 *Rollout Concept (SPIRE-SAIS Training Ecosystem Approach)*

The SPIRE-SAIS rollout followed an **ecosystem approach**. The aim was to develop and strengthen a successful partnership in the respective sectors and regions. In this way, a skills and training ecosystem is to be created that integrates various stakeholder groups from different sectors of society in the sense of a quadruple helix. The focus was on the four groups of education and training providers (1), small and large businesses (2), public authorities (3) and civil society actors (4).

Targeted rollout activities included (a) education entities and training bodies, (b) companies' experts, practitioners and engineers, (c) decision-makers at local, regional, national and European level, and not at least (d) the sector associations and their members. The SAIS partners of the respective sectors and regions helped organising and took part in the workshops, while associated SAIS partners as well as new interested and relevant organisations were also in-

tegrated into the rollout. However, the implementation (D6.1; Schröder et al., 2022) and exploitation plan (D6.3; Schröder, Branca, & Woodcock, 2024) set the decent ground for a rollout at sectoral, national and regional level. As already said, SPIRE-SAIS sets a focus on the sectoral level (engaging the sector associations) and the regional level and the Hubs for Circularity of Processes for Planet and the ECoP H4C, integrating the skills adjustment in existing and to be developed Industrial Symbiosis projects or regional ecosystems linking together different sectors for waste, emission and energy reduction (see example of our associated partner ARGO in Figure 51).

Figure 51: Industrial Symbiosis on the Regional Level (Example ARGO)

Beside the continuous rollout and dissemination activities of the partners, the further SPIRE-SAIS sectoral and regional rollout was organised in the form of pilot workshops and round table discussions with stakeholders from the respective sectors and regions. The individual workshops were scheduled to last around 3 hours, whereby great importance was attached to interactive elements and a lively exchange with the participating stakeholders. In the first rounds of workshops, it was particularly important to verify stakeholder interest and ensure that the various stakeholder groups were willing to participate in events and drive processes forward. Above that, it was also important to have a reliable point of contact for each rollout sector and rollout region to provide support with invitations and the definition of key topics. Such points of contact were found, as mentioned, via sector associations (such as ESTEP in the steel sector) or via regional organisations (such as ART-ER in the Italian region of Emilia-Romagna).

The SPIRE-SAIS survey on technological and economic development (see chapter 2.1) underlines the integration of public actors in the development of IS and EE. Besides company internal actors (managers of functional areas like quality, energy, etc.) and other industrial sector actors (from other industries, financial partners, etc.), also public actors (e.g. public authorities or parties, local agencies) are engaged in IS (19%) and EE (43%), underlining that particular attention should be paid also to the integration of public parties, local agencies, and civil society organisations.

A **sectoral approach** for the SPIRE-SAIS rollout is useful to explore the specialised needs and solutions of different sectors. Thereby, the different energy-intensive industries face individual challenges and opportunities in terms of Industrial Symbiosis and Energy Efficiency. A sectoral approach enables the development of customised solutions that address the specific requirements of the industry, the technological processes and the regulatory environment. It is also important to gain feedback from the different sectors with regard to the developed tools of the project. At the same time, sector-specific best practices can be shared. Although SPIRE-SAIS generally pursues a cross-sectoral approach, different sector-specific training courses were also developed in the project. At that, a sector-specific rollout ensures that the training is relevant and directly applicable in the sectors.

At the same time, SPIRE-SAIS also follows a **regional approach**. On the basis of regional workshops, regional challenges and opportunities were thereby considered. After all, different regions have different environmental priorities, legal frameworks and available resources (such as types of waste or energy sources) that are relevant for IS and EE. A regional approach makes it possible to address these specific regional characteristics. In addition, a variety of sectors are often represented in the individual regions, resulting in cross-sectoral synergies. Regional workshops can thereby foster cross-sector collaboration and create innovative, symbiotic relationships that drive skills development and training for IS and EE. A SPIRE-SAIS rollout at the regional level also enables broader participation of stakeholders, including local governments and educational institutions, who can support and strengthen the implementation of training measures.

As a third pillar and in the activities beyond the project life span a closer cooperation with the regional hubs and industrial park for circularity is foreseen in cooperation with the ECoP H4C.

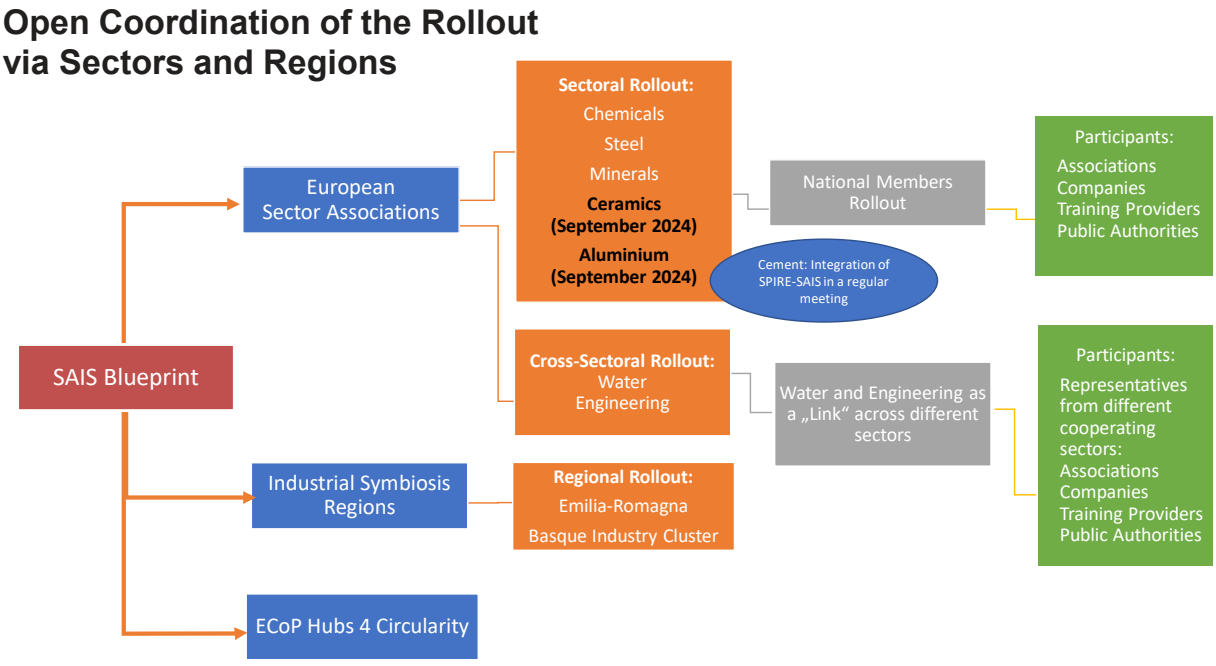


Figure 52: Sectoral and Regional Rollout of the SPIRE-SAIS Blueprint

The **thematic focus** of the SPIRE-SAIS rollout was, on the one hand, a general introduction to the project concept. At the same time, the results of the identified job profiles and skills, including the skills categorisations, were presented. Special attention was paid to the presentation of the online platform SKILLS4Planet and the training courses for Industrial Symbiosis and Energy Efficiency. Constructive feedback from stakeholders on user-friendliness of the

SPIRE-SAIS tools was thereby not the only important issue of the SPIRE-SAIS rollout workshops. Rather, the aim was also to gain concrete insights into the actual sectoral and regional demands, challenges and opportunities with regard to Industrial Symbiosis and Energy Efficiency in general and for IS and EE skills development in particular. This made it possible to integrate industry demands for the tools and results that were developed and obtained in SPIRE-SAIS. The exchange between the stakeholders present also enabled new learning opportunities to be identified for the respective sectors and regions and new support structures to be established. The overall aim of the SPIRE-SAIS training ecosystem is to continuously contribute to improving the quantitative and qualitative participation of workers and residents in lifelong learning in European regions through the rollout workshops.

Summarised, the SPIRE-SAIS regional training ecosystem has the following approach, objectives and characteristics:

- A successful partnership in a sector/country/region to strengthen and develop a skills and training ecosystem of:
    - Education and training providers
    - Small and large business
    - Public authorities
    - Civil society
- The **Sectoral/National/Regional Training Ecosystems** will:
    - indicate new learning opportunities and support structures
    - integrate industry demands as a structural principal of the sectoral/national/regional education and training system
    - orientate on learning outcomes (instead of curricula)
    - emphasize the growing demand and challenge for every single person
    - improve quantitative and qualitative participation of lifelong learning of the workers and inhabitants (national/regional).
- The **implementation process of the Training Ecosystems** is characterised by:
    - a quick start within a "corridor of possible developments“
    - new possibilities to get hold of and mobilise potential trainings
    - an increased potential for education to become a “location factor” for integrated regional-local development.

5.2 *Results and Learnings*

Rollout workshops have been held in 5 sectors to date: In the first half of 2023, workshops were held in the steel sector, the minerals sector and the chemicals sector. In March 2024, the rollout workshop took place in the water sector, and in April 2024 in the engineering sector. The rollouts for the aluminium sector and the ceramics sector are planned for the second half of 2024.

Regional workshops were held in the Italian region of Emilia-Romagna and in the Basque Country. The workshop in Emilia-Romagna was organised in close cooperation with ART-ER, the rollout in the Basque Country was organised in cooperation with the CORALIS project and SIDENOR.

In the following the learnings and general results from the rollout workshops are summarised.

5.2.1 Uptake, cooperation and awareness for IS

The important task of raising awareness of circularity in general and for Industrial Symbiosis in particular was one of the most discussed topics in the rollout workshops. While some of the stakeholders emphasised that IS related to the Circular Economy has been an issue across the EU for many years, the term often seems new nonetheless, even though many of the practices are already in use.

Although awareness of the practice still needs to be raised, some sectors show that Industrial Symbiosis is widespread when the added value is clearly demonstrated. In addition to the added value for multiple partners, knowledge creation and viable business cases are some of the main motivators fuelling the adoption of Industrial Symbiosis. According to stakeholders from the minerals, chemicals and steel industries, Industrial Symbiosis in general represents an opportunity for companies, although it is often not possible to easily replicate practices. The results show that companies often redevelop their own solutions instead of sharing and strategically collaborating. At the same time, many companies seem to have little awareness of the circular economy and possible collaborations in the field of Industrial Symbiosis and are therefore sometimes unable to analyse and constantly update the changing skills and qualification requirements themselves. Therefore, a thorough analysis is needed to adapt the Industrial Symbiosis approach to individual companies and locations. In other words, the challenge is to apply valuable IS solutions in companies without having to reinvent the wheel every time. The cross-fertilisation of ideas between different IS projects (e.g. between SPIRE-SAIS and the CORALIS project) shows their complementarity and the benefits of collaboration.

On the other hand, the rollout workshops showed that the partners in some regions have very in-depth and comprehensive knowledge of the topic and are quite capable of realising projects together. Through the activities of the SPIRE-SAIS project, regional and sectoral European skills alliances were established and cooperation for the future implementation of Industrial Symbiosis was made possible. Although regional networks often already existed, the SPIRE-SAIS workshops helped to identify synergies between stakeholder groups and initiate regional development processes.

Among one of the **main challenges for the uptake of Industrial Symbiosis** is the lack of connections between companies, especially in terms of information and communication. There also seems to be a lack of channels and connectors, as well as a lack for a global vision for Industrial Symbiosis. Above that, upskilling and reskilling of workers and student training are seen as essential prerequisites to adequately prepare employees for circular economy processes. According to the participants, companies often do not seem to be aware of which skills are required for Industrial Symbiosis.

5.2.2 Training for Industrial Symbiosis

The participating stakeholders emphasised very clearly that skills development and training are among the most important tasks with regard to the implementation of Industrial Symbiosis and Energy Efficiency. Identifying the necessary skills is a major challenge for companies and a first step that must be taken before employee training is even possible.

With regard to training for Industrial Symbiosis, it was mentioned in the workshops that EU policies often evolve and change faster than training offers; it thereby seems challenging to quickly adapt the training offer to the increasing requirements of EU policies. In this respect, communication is of utmost importance - not only between different industrial sectors, but also between sectors and the European Commission.

The experts in the workshops also emphasised with regard to skills adjustment and training that it is not only technical skills that are important in the topics of Industrial Symbiosis and Energy Efficiency. Rather, it is above all transversal skills and soft skills that can facilitate co-operation between different sectors, as is suggested by the SPIRE-SAIS skills categories. An important question is to what extent skills can be transferred between different energy-intensive sectors.

5.2.3 Talent Attraction & retention in energy-intensive industries

The sectoral workshops show that the challenges with regard to skill needs and recruiting differ regionally. In the Finnish chemical and battery sector, for example, there is a high demand for skilled labour. Thousands of skilled workers are currently needed, but these are currently lacking on the Finnish labour market. The situation is very different in the Italian region of Emilia-Romagna: there are enough qualified workers and good training opportunities here, but the (primarily green) transformation of the chemical sector and the associated challenges are resulting in job losses. As a result, labour is migrating from the Emilia-Romagna region to other regions and countries. In the chemical sector in general, it can also be observed that the demand for qualified workers is currently generally lower due to decarbonisation efforts. However, the experts are certain that the demand will increase again in the next few years, so that it is all the more important to keep qualified personnel in the sector.

It is evident across all sectors that Industrial Symbiosis processes often depend on the skills of individual persons, which increases the need for further education and training. Accordingly, the topics of talent attraction and talent retention should always be considered in order to ultimately develop and integrate IS-related competences. HR and management teams at company level should therefore also be integrated in discussions.

5.3 *Summary and Next Steps: European Community of Training Practice*

The SPIRE-SAIS project and further rollout workshops can help to bring stakeholders together and establish important contacts. SPIRE-SAIS can act as a connector, e.g. in the steel sector, to introduce topics in the ESTEP Focus Group Circular Economy. At the same time, A.SPIRE can provide a link to experts in the Permanent Working Groups (PWGs), especially the PWG Societal Innovation.

The rollout workshops revealed specific needs and solutions at regional and sectoral level, which in turn were used to adapt and further develop the overarching European tools (such as SKILLS4Planet) for skills development. At the same time, these tools have been and are being applied and disseminated at regional and sectoral level. Despite the complex diversity of actors, backgrounds and organisational logics, this enables a process of social innovation that efficiently and effectively promotes the decarbonisation and circularity of European industry.

Nevertheless, the results of the rollout workshop showed that there is a relevant need for a **European Community of Sectoral-National-Regional Skills and Training Practice**. In terms of rollout to regions where cross-company and cross-industry Industrial Symbiosis is already in place, we are looking for a smart integration of the skills and training perspective as it is developed by the SPIRE-SAIS Blueprint.

Therefore, the pilot rollout workshops are only a first step. They need to be continued and expanded. As the rollouts for the aluminium sector and the ceramics sector are planned for the second half of 2024, it shows the need for continuity beyond the project life span. In particular,

the further integration of the SPIRE-SAIS Blueprint and the European SKILLS4Planet Training Platform within further regions and sectors should lead to an integrated European Community of Training Practice (ECoP). Within regional training ecosystems (including public authorities and policy, big companies and SMEs, social partners, educational organisations and training providers, as well as civil society organisations), the SPIRE-SAIS European Training Platform could contribute in the following ways:

- Serve proactive skills assessment and adjustment,
- Analyse continuously and proactively skills gaps,
- Provide up-to-date support and knowledge by collecting and developing up to date training modules and tools.

Via such a Community of Training Practice for connecting and networking of regions (with H4C) not only exchanging tools and knowledge across regions is given but also by mutual learning, not reinventing the wheel several times new.

Such a European Community of Practice ensures cooperation and learning between the European, sectoral, national and regional levels. This includes beside the existing regional training ecosystems of ESSA and SPIRE-SAIS the integration of Hubs for Circularity, Centres of Vocational Excellence (CoVE), circular economy centres and industrial parks, as well as new regions in underrepresented sectors in the partnership (e.g. cement).

6 Policy Recommendations

During the project's implementation and the roll-out of the Blueprint for Energy Intensive Industries and Industrial Symbiosis, specific policy recommendations have emerged in order to support the integration of skills adaptation into strategies and policy support measures. Moreover, several solutions have been developed and tested during the project's activities to support the implementation of these recommendations. The SPIRE-SAIS Blueprint framework provides specific measures, tools, cooperation and alliances to serve as a strong basis for addressing gaps in skills adaptation and training programmes. SKILLS4Planet can serve not only as an up-to-date skills assessment and training tool but also as a collaboration platform between different sectors and various stakeholders.

The policy recommendations summarised in the following (see in detail D7.1; Tropeoli et al., 2024) have been grouped according to the level of stakeholders addressed, such as European, national or general (overarching).

6.1 *Overarching Policy Recommendations*

- Increase the level of awareness of IS practices and relevant (green) skills by establishing a common terminology, increasing the level of green skill awareness, developing information on good practices for VET institutions
- Increase attention to sector specifics within a cross-sectoral approach
- Ensure regular monitoring of skills demand and supply and adaptation of strategies to pro-actively address the emerging needs
- Integrate the provisions of Industry 5.0, human-centricity and sustainability by developing pieces of training that emphasise the human side of digital technologies, continuous training in digital skills and a sustainable industry

6.2 *European Policy Recommendations*

- Develop a European-coordinated strategy integrating cross-sectoral and sector-specific aspects
- A strategy for green skills in VET through the development of green skills, dual VET systems in a European compatible format, fostering collaboration and strengthening existing systems
- The definition of new strategies should be aligned with relevant stakeholders and existing training programmes, platforms and schemes
- Establish an integrated course structure and tools for IS/EE
- An open online training and support platform should be provided to all interested stakeholders.
- Implementing instruments and providing funding to support the development of green skills and required training

6.3 *National and Regional Policy Recommendations*

- National policymakers should collaborate with sectors, VET institutions, and industry organisations, to promote green skills and train teachers to provide current theoretical and practical knowledge to students
- Develop monitoring and evaluation tools to better assess existing green skills delivery instruments and the educational programs' effectiveness
- Incorporating green skills into national secondary education systems
- Create a unified skills recognition system
- Ensure the integration of EE and IS concepts and (online training) tools into the qualification processes at the national and VET school level
- Develop training for intersectoral transitions
- Develop a train-the-trainer strategy to increase educators' readiness
- Incentivise employers to provide training opportunities for employees

6.4 *Specific Recommendations for Individual Companies and Organisations*

- Designing internal HR and training strategies that increase the level of green skills awareness and training within companies
- Establish collaboration with training providers to provide feedback on industry needs to national policymakers, VET institutions and other stakeholders
- Raising awareness and readiness of company staff to implement IS through self-assessment, training programmes and exchange of good practices
- Facilitate workers' involvement in training programs through increased training offers in companies, financial and non-financial support, promotion of apprenticeships, various training formats and peer learning
- Spotlight image of IS and EE and improve recruitment and retention of young talent.

7 Outlook: Ongoing Skills Alliance within the LSP Energy Intensive Industries of the European Pact for Skills

Our Mission of a continuous and **proactive adjustment of the future skills demands by the industry and for the industry** remains for the ongoing activities of SPIRE-SAIS beyond the funded project time.

Figure 53: Mission and main objectives of SPIRE-SAIS

The roadmap is characterised by the already existing five central elements for the further and continuous implementation and running of the SPIRE-SAIS Skills Alliance: Technological and Economic Foresight and Skills Adjustment, Strategies and Measures, Alliances and Leadership, and further Implementation and Rollout – bundled in the Foresight Observatory, the SKILLS4Planet online platform, and the European Community of Training Practice, foreseen for coordinating national-regional rollout activities.

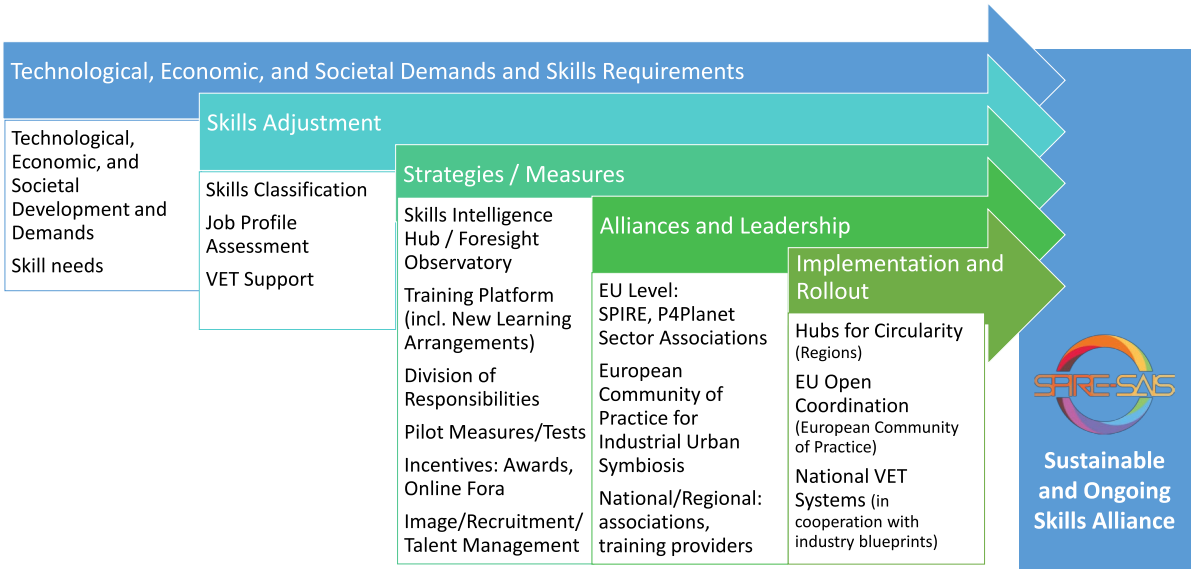


Figure 54: SPIRE-SAIS Roadmap

The Observatory, SKILLS4Planet and the European Community of Practice are now part of the European governance structure of SPIRE-SAIS, linked with to existing European platforms and tools of the Energy Intensive Industry. This also ensures the exchange with the wider European process industry: mainly by being part of the **Large Scale Partnership Energy Intensive Industries** (LSP EII) under the Pact for Skills, within the European Steel Skills Alliance (ESSA) and the Clean Steel Partnership, the Process for Planet programme and A.SPIRE. The governance structure of SPIRE-SAIS is built on a division of responsibilities, clarified and checked with the European industry associations and social partners (industriALL). Connections with European platforms beyond the sectors (e.g. CEDEFOP Skills Intelligence, Centres of Vocational Excellence) and tools (e.g. ESCO, Europass, ECVET) are part of the SPIRE-SAIS strategy, measures and training (esp. in SKILLS4Planet and the Sectoral-National-Regional Rollout). Within the next steps SPIRE-SAIS will have a closer look at other regional approaches (such as Smart Specialisation, Cluster Platforms, Centres of VET Excellence and others).

The governance of SPIRE-SAIS is deeply embedded in relevant A.SPIRE / P4Planet structures and especially in the Large Scale Partnership Energy Intensive Industries (LSP EII) of the European Pact for Skills. Key elements and offers of the SPIRE-SAIS Blueprint are:

1. The European Technology and Skills **Foresight Observatory** as the main European coordination unit, conducting a regular European Steel **Technology and Skills Foresight Panel –** aligned with the P4Planet PWG Societal Innovation and the Foresight Team
2. The Online Training Ecosystem **SKILLS4Planet –** aligned with the steelHub and H4C platform
3. The **European Community of Training Practice**, connecting and supporting the different sectors and European regions with a European platform for existing and emerging Sectoral-**National-Regional Training Ecosystems** aligned with the H4C platform and the Steering Committee Sector Representatives.

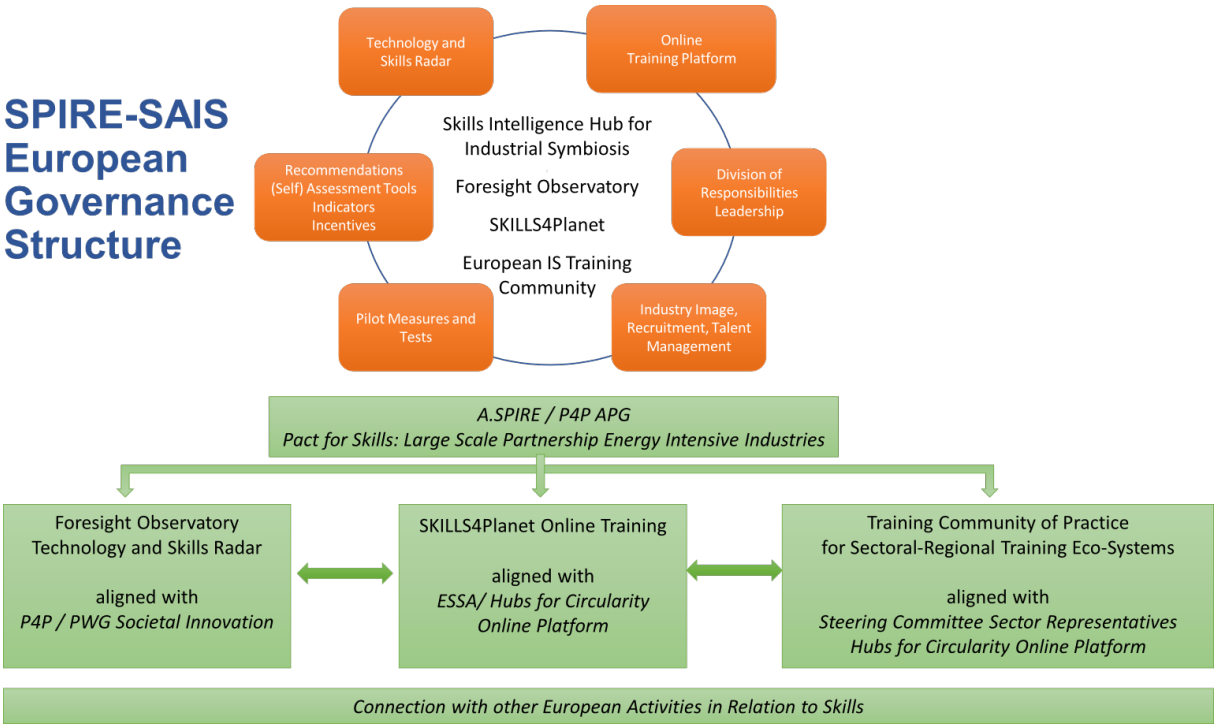


Figure 55: SPIRE-SAIS European Governance Structure

The European Foresight Observatory will bundle all the necessary activities to (a) **monitor and evaluate** regularly technological and economic developments and related industry skills requirements and (b) to ensure the alignment and support of the Online and Regional Training Ecosystems. Central part of the Foresight Observatory will be a regular annual **foresight survey.** Based on the results of this survey a **Technology and Skills Foresight Index** will be established, showing also trends over the time. Expert Panel Workshops will discuss these quantitative results more in-depth and qualitatively.

The Foresight Observatory will operationalise the roadmap (see Figure 54), to ensure monitoring and adjustment of skills (demand side) and to organise education and training for them (supply side).

- **Monitor and anticipate** new skills demands of the EU Energy Intensive Process Industry via the observatory
- Provide and promote training in **T-shaped skills** of the main job profiles concerned
- Support the further extension of the **Online (SKILLS4Planet) and Sectoral Regional Training Eco-Systems**
    - Promote new learning arrangements
    - Expand and promote relevant **digital** and **on-the-job training**
    - Communicate on the importance of lifelong learning
    - Promote **(reverse) mentorship** as a way of knowledge transfer
- Improve the **image** of the industry and careers
    - Initiate EU-wide communication campaigns
    - Advertise and promote job opportunities in the sectors to candidates of varied disciplines (incl. a new diversity by women, migrants, etc.)
    - Advertise good working conditions Promote Energy Intensive and related Process Industries in primary and secondary schools (pre-VET)
    - Conduct skills awareness-raising campaigns
    - Include underrepresented groups, such as women and migrants

    - Document and award best practices (of skills adjustments)
- **Pilot measures and tests** using existing **funding** tools on the European (P4Planet and other Horizon Europe clusters, RFCS, Erasmus+, and others), national and regional level (ESF, EFRE, ...) (initiated and coordinated by the Foresight Observatory)
- **Incentives** by generating good or best practice awards, online forum(s), best practice exchange and others (e.g. as part or integrated in the activities of the Foresight Observatory)
- **Division of responsibilities** for ensuring the update of learning lifelong between companies/industry/social partners - VET systems - the individual worker.

More training modules and offers from the companies and training providers will be collected and integrated in SKILLS4Planet. On the job, on-site training in companies and VET schools are mainly part of the Sectoral-National-Regional Training Eco-Systems to be combined with online training if possible.

7.1 *Large Scale Partnership Energy Intensive Industries (Pact for Skills)*

Essential component for the sustainable further running and connecting the European Skills Alliance and Agenda of SPIRE-SAIS is its integration in the Large Scale Partnership Energy Intensive Industries (LSP EII)[16] under the Pact for Skills. This already established partnership integrates the European Steel Skills Alliance and Agenda ESSA, the Skills Alliance for Industrial Symbiosis SPIRE-SAIS, and the Chemicals Blueprint ChemSkills. Based on a Memorandum of Understanding the Blueprints will merge under a common umbrella with specific foci:

- SAIS = cross-sectoral and Industrial Symbiosis skills specific blueprint
- ESSA = example of a specific sector (steel) related blueprint including an incremental upskilling of representative job profiles (t-shaped skills: technical and transversal skills (green, digital, social, individual, and methodological)).
- ChemSkills = sector specific skills for the digital and green transformation of the chemicals industry, including several sub-sectors.

The LSP EII was already launched at the 10th of May 2023, endorsed by Commissioner Schmit and Commissioner Breton (European Commission, 2023). Sectors represented so far are Steel, Minerals, Water, Engineering, Logistics, Non-Ferrous Metals (Aluminium), Ceramics, RawMaterials, Welding, Chemicals, Cement, Refinery. The partnership is composed of Blueprint members (beside SPIRE-SAIS ESSA and ChemSkills) and new additional members; up to now 41 signatories: 8 companies (also training providers), 12 industry associations, 1 union, 1 industry park, 6 training providers, 13 consultancies and research institutions (most of them are also training providers).

[16] https://pact-for-skills.ec.europa.eu/about/industrial-ecosystems-and-partnerships/energy-intensive-industries_en

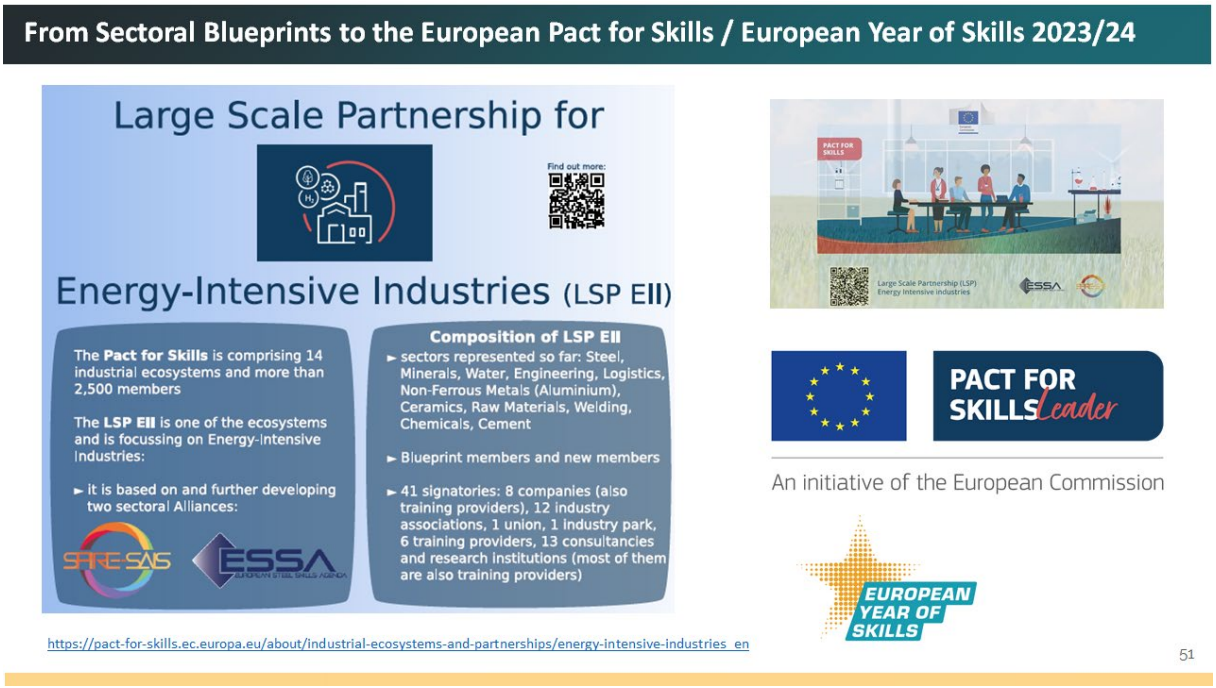


Figure 56: Large Scale Partnership Energy-Intensive Industries

With the partnership of the LSP EII and other Pact for Skills members we intend to use and further expand the already existing infrastructure, tools and measures of the ESSA and SPIRE-SAIS with a stronger cross-sectoral, a sectoral and a national-regional focus

- Transfer of sector specific findings to the other sectors (e.g. transversal skills), complementing the mainly VET (EQF levels 3-5) oriented Blueprints ESSA and SPIRE-SAIS with higher education strategies, measures and tools (EQF levels 6-8).
- Integrating the existing online training platforms steelHub and SKILLS4Planet into an overarching HUB5.0 platform, with new cross-sectoral and sector-specific trainings and micro-credentials and an overarching Capability Assessor (skills assessment)
- Looking for “Game Changer” related new job profiles and related skills as well as key challenges such as human-centricity of Industry 5.0, Artificial Intelligence, decarbonisation and hydrogen use, talent attraction, and others.
- Further sectoral rollouts to identify the needs and hot topics of each sector, specific topics for the roll-out workshops will be defined and discussed with the participating industry associations, company representatives, and representatives from vocational and higher education.
- Cooperation and mutual learning between the European, sectoral, national and regional levels. This includes the integration of Hubs for Circularity, Centres of Vocational Excellence (CoVE), the existing regional training ecosystems of ESSA and SPIRE-SAIS, Hubs for Circularity, circular economy centres and industrial parks, as well as new regions in underrepresented sectors in the former SPIRE-SAIS partnership (e.g. pulp&paper, refinery) and the integration of the new sectors of the LSP EII (e.g. Raw-Materials, Welding, Logistics).

8 Annex

8.1 *List of Abbrevations*

Abbreviation	Meaning
4R	Reduce, Reuse, Recycle and Restore
5R	Reduce, Reuse, Recycle, Restore and Re-Education
ADDIE	Analysis, Design, Development, Implementation, Evaluation
AIChE	American Institute of Chemical Engineers
CCRI	Circular Cities and Regions Initiative
CCS	Carbon Capture Storage
CCU	Carbon Capture Utilization
C&D waste	Construction and Demolition waste
CoVEs	Centres of Vocational Excellence
CSP	Clean Steel Partnership
CVET	Continuing Vocational Education and Training
D	Deliverable
DG	Directorate General
ECESP	Circular Economy Stakeholder Panel
ECVET	European Credit System for Vocational Education and Training
EAF	Electric Arc Furnace
ECoP	European Community of Practice
ECoP U-IS	European Community of Practice for Urban Industrial Symbiosis
ECTS	European Credit Transfer and Accumulation System
EE	Energy Efficiency
EFRE	European Regional Development Fund
ENEA	Energy Efficiency Action Plan
EntreComp	Entrepreneurship Competence Framework.
EQF	European Qualifications Framework
EQAVET	European Quality Assurance in Vocational Education and Training

ESCO	European Skills, Competences, Qualifications and Occupations
ESF	European Social Fund
ESF+	European Social Fund Plus
EU	European Union
FP6	Sixth Framework Programme
FP7	Seventh Framework Programme
H2020	Horizon 2020
H4C	Hubs for circularity
HE	Higher Education
HR	Human resources
IS	Industrial Symbiosis
ISCO	International Standard Classification of Occupations
I-US	Industrial Urban Symbiosis
IT	Information Technology
IVET	Initial Vocational Education and Training
JECE	Junior Expert in Circular Economy
KPI	Key Performance Indicator
LSP EII	Large Scale Partnership Energy Intensive Industries
NEET	Not in Education, Employment or Training
NGO	Non-governmental organisation
P4Planet	Processes for Planet
pre-VET	pre Vocational Education and Training
PWG	Permanent Working Groups
RFCS	Research Fund for Coal and Steel
R&D	Research & Development
R&I	Research & Innovation
SCORM	Shareable Content Object Reference Model
SET Plan	Strategic Energy Technology Plan
SMART	Specific, Measurable, Achievable, Realistic and Time-bound

SMEs	Small and medium-sized enterprises
SPIRE-SAIS	Skills Alliance for Industrial Symbiosis: A Cross-sectoral Blueprint for a Sustainable Process Industry
SRIA	Strategic Research and Innovation Agenda
SRL	Symbiosis Readiness Levels
STEM	Science, technology, engineering, and mathematics
U-IS	Urban Industrial Symbiosis
VET	Vocational Education and Training

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8.3 *Key Definitions*

- **Industrial Symbiosis** *("Study and portfolio review of the cluster of projects on Industrial Symbiosis directorate Prosperity in DG Research and Innovation: Findings and recommendations". European Commission. March 2020).* The definition is from a CEN Workshop Agreement on Industrial Symbiosis in 2018: *"Industrial symbiosis is the use by one company or sector of underutilised resources broadly defined (including waste, by-products, residues, energy, water, logistics, capacity, expertise, equipment and materials) from another, with the result of keeping resources in productive use for longer."*
- **Energy Efficiency:** *'Energy efficiency' means (technically) the ratio of output of performance, service, goods or energy, to input of energy.[DIRECTIVE 2012/27/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 October 2012 on Energy Efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC] In industrial context, Energy efficiency simply means using less energy to perform the same tasks required to provide products and services. It refers to more efficient, conservative use of energy across all sectors– that is, eliminating energy waste. Energy efficiency brings a variety of benefits: reducing greenhouse gas emissions, reducing demand for energy imports, and lowering our costs on a household and economy-wide level. [EESI,CEDEFOP,SPIRE-SAIS WP3]*
- **Skill, Competence, Knowledge, Attitude, Task, Qualification:** According to the European Qualifications Framework (EQF) and European e-Competence Framework (e-CF), 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. ILO (International Labor organization) defines 'skill 'very firmly, as the ability to carry out the tasks and duties of a given job ESCO and European Qualifications Framework (EQF) applies the same definition of "skill" as 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). (https://ec.europa.eu/esco/portal/escopedia/Skill) [Cedefop; European Parliament and Council of the European Union, 2008.]

- **Competences:** 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. (https://ec.europa.eu/esco/portal/escopedia/Competence)
- **Knowledge**: "Knowledge is sometimes viewed as if it was a concrete manifestation of abstract intelligence, but it is actually the result of an interaction between intelligence (capacity to learn) and situation (opportunity to learn), so is more socially-constructed than intelligence. Knowledge includes theory and concepts and tacit knowledge gained as a result of the experience of performing certain tasks. Understanding refers to more holistic knowledge of processes and contexts and may be distinguished as know-why, as opposed know-that." [Typology of Knowledge, Skills and Competences, CEDEFOP, 2006].
  According to the e-CF (European e-Competence framework), knowledge represents the set of know-what, such as programming languages or design tools, while the EQF 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. (https://ec.europa.eu/esco/portal/escopedia/Knowledge)
- **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.
- **Tasks:** 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.
- **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" (https://www.cedefop.europa.eu/node/11256

8.4 *Facts and Figures*

8.4.1 CERAMIC SECTOR

<table>
<tr><td> 
</td><td colspan="3">CERAMIC</td></tr>
<tr><td>SUBSECTORS
  </td><td colspan="3">Walls and floor tiles, Bricks and roof tiles, Refractories, Technical ceramics, table and ornamental ware, Sanitaryware, Expanded clay, Clay pipes, Porcelain enamel</td></tr>
<tr><td>DIRECT JOBS
  </td><td>200 000</td><td>PRODUCTION (€)
  </td><td>31 bn</td></tr>
<tr><td>ENERGY
  </td><td colspan="3">Fuel is used to obtain the temperature needed for the processes: spray-drying, drying and firing processes. There is still potential to reduce the energy needed. According to the sector’s 2012 roadmap electrification could be possible but this is not yet economically viable or demonstrated. Besides electricity, bioenergy or hydrogen can be used to replace fossil fuels if new burners are developed and tested. Moreover, ceramics is also looking into the possibility of developing microwave-assisted gas firing (MAGF) kilns

The process emissions can be mitigated using CCS or CCU (Carbon Capture and Storage and Utilization, respectively).</td></tr>
<tr><td>WASTE
  </td><td colspan="3">Most of the process residues (unfired and fired scrap tiles, sludge from cleaning operations, waste from mechanical treatments, among others) can be fed back into the process.

Most end-of life ceramics are found in construction and demolition waste, these could be reused to make new ceramics applying an appropriate C&D Waste sorting out process</td></tr>
<tr><td>RAW MATERIALS
  </td><td colspan="3">Access to raw materials (bauxite, silicon carbide, magnesia, etc.) is a key factor regarding ceramic sector competitiveness</td></tr>
</table>

INDUSTRIAL SIMBIOSYS (IS)	A very extended example of IS in the ceramic sector is the re-use of water used in the manufacturing process in the raw material preparation process. Other example is the use of recycled material (urban residues, internal or external residues from production processes and ceramic products at the end-of life) as a substitutive for raw materials.
REFERENCES	Spire, 2021, BEIS, 2017Cerame-Unie, 2012, Cerame-Unie, 2012, Cerame-Unie, 2021Raw materials, metals, minerals and forest-based industries | Internal Market, Industry, Entrepreneurship and SMEs (europa.eu)

8.4.2 STEEL SECTOR

	**STEEL**		
SUBSECTORS	Steel is primarily made using two different technologies: • Integrated steel plants are used to make primary steel (i.e. virgin steel) mostly from iron ore, which is extracted from mines, and a small share of scrap steel. • In contrast, in an electric arc furnace (EAF), scrap steel and/or scrap substitutes such as direct reduced iron (DRI) are melted using electrical energy;		
DIRECT JOBS	Steel is a genuine EU industry with 500 production sites across 23 EU countries and employed 320,000 people directly. The total number of jobs enabled by the steel industry is 7.9 times the steel industry's own employment	**PRODUCTION (€)**	The steel sector in Europe has an annual turnover of EUR 166 billion. With an output of 168 million tonnes of crude steel per year (10% of global production), the EU is the second-largest producer in the world.

ENERGY 	Energy and carbon (coking coal) are used to separate iron from oxygen in an energy-intensive blast furnace; besides coal, electricity and natural gas are used; in an electric arc furnace (EAF), scrap steel is melted using electrical energy;
WASTE 	During the iron- and steelmaking processes, several wastes are produced, such as slags, dusts, mill-scales and sludges. On average, for one tonne of steel 200 kg in the scrap-based steelmaking and 400 kg in the iron ore-based steelmaking of by-products are produced
RAW MATERIALS 	Access to raw materials (Iron ore, scrap, alloys, lime, etc.) is a key factor regarding steel sector competitiveness
INDUSTRIAL SIMBIOSYS (IS) 	In general, by-products generated in the iron- and steelmaking processes can be used in different sectors: • iron oxides and slags can be used for external applications, such as Portland cement • zinc oxides, produced in the EAF route, can be used as a raw material mainly through the Waelz process • gas from iron- and steel processes are cleaned and internally used, for instance, for producing electricity On the other hand, by-products from other industrial sectors can be applied in the steel industry a secondary and recycled materials (biomass, residues from food companies, plastic and rubber wastes)
REFERENCES 	Clean Steel RoadMap, ESTEP Strategic Research Agenda, ESTEP

8.4.3 CEMENT SECTOR

<table>
<tr><td> 
</td><td colspan="3">Cement
(NACE C23.5, Manufacture of cement, lime and plaster)</td></tr>
<tr><td>SUBSECTORS
  </td><td colspan="3">Cement, lime, plaster</td></tr>
<tr><td>DIRECT JOBS
  </td><td>83252</td><td>PRODUCTION (€)
  </td><td>56bn</td></tr>
<tr><td>ENERGY
  </td><td colspan="3">"60-70% of the carbon results from the breakdown of limestone, which is a chemistry driven process and hard to reduce through ARM/ substitution. The remaining 30-40% derives from the fuel and can be substituted"</td></tr>
<tr><td>WASTE
  </td><td colspan="3">"Most of the process residues (waste heat, cement kiln dust) can be fed back into the process or into other processes (see below). End of life cement is bound up in concrete and other construction and demolition waste, often recycled back into sectoral applications.</td></tr>
<tr><td>RAW MATERIALS
  </td><td colspan="3">MINERALS (CLINKER, LIMESTONE, CLAY, GYPSUM) AND FUEL</td></tr>
</table>

INDUSTRIAL SIMBIOSYS (IS) 	"Inputs through IS: paper sludge and clay, gypsum (clinker), blast furnace and steel slag, copper and nickel cleaned slag, waste plaster iron slag, iron oxide, used tires, waste plastics, salt slag for aluminium oxide, waste casting sand and sewage sludge. automotive shredder residue, foundry sand, waste paint, waste solvents, MSW incinerator ash, wastewater sludge, beer sludge, waste filtering material, rice hulks, meat, bone and fat from meat processing, silica fume, spent pot liner, fly ash, by-products of cement production used by other industries, cement and lime kiln dust is used for road stabilization and soil treatment, waste heat for district heating, nickel zine copper and lead to secondary smelters. • Pulverised Fuel Ash, waste from coal-fired power plants, to substitute for clinker. • Cement kiln dust, used bricks from kiln lining and rejected concrete roof tiles can all be fed back into the process to replace virgin materials. • Broken moulds from the ceramics industry are being used to replace mined gypsum • Waste foundry sand and gypsum • Mill scale (flakes of oxide coating) from steel rolling to provide iron oxide • Dried sludge from wastewater treatment • Ground granulated blast furnace slag (from iron manufacture) and PFA can also be used to partially replace cement in concrete • Water can be supplemented with treated waste water and site drainage run-off."
REFERENCES	IDEA 2015, Sizing IS market

8.4.4 MINERALS SECTOR

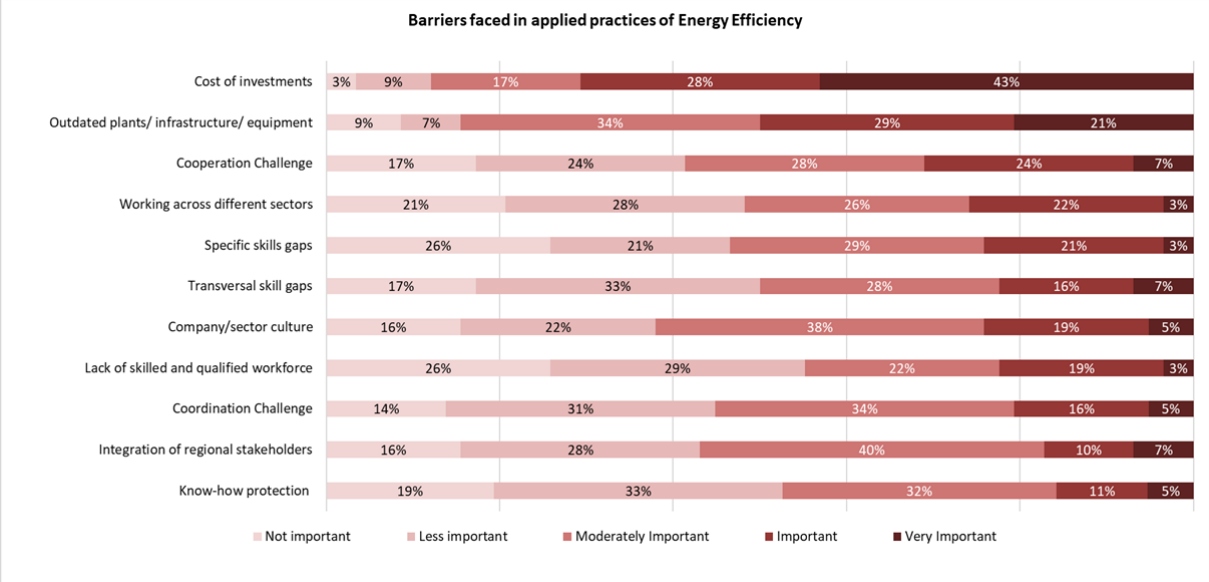
	**MINERALS**
SUBSECTORS 	Minerals sector association covers and represent the interests of multiple minerals such as: andalusite, bentonite, borates, calcium carbonate (precipitated and ground), diatomite, dolomite, feldspar, limestone, lime, kaolin, plastic clay, sepiolite, magnesite, silica sand and talc.

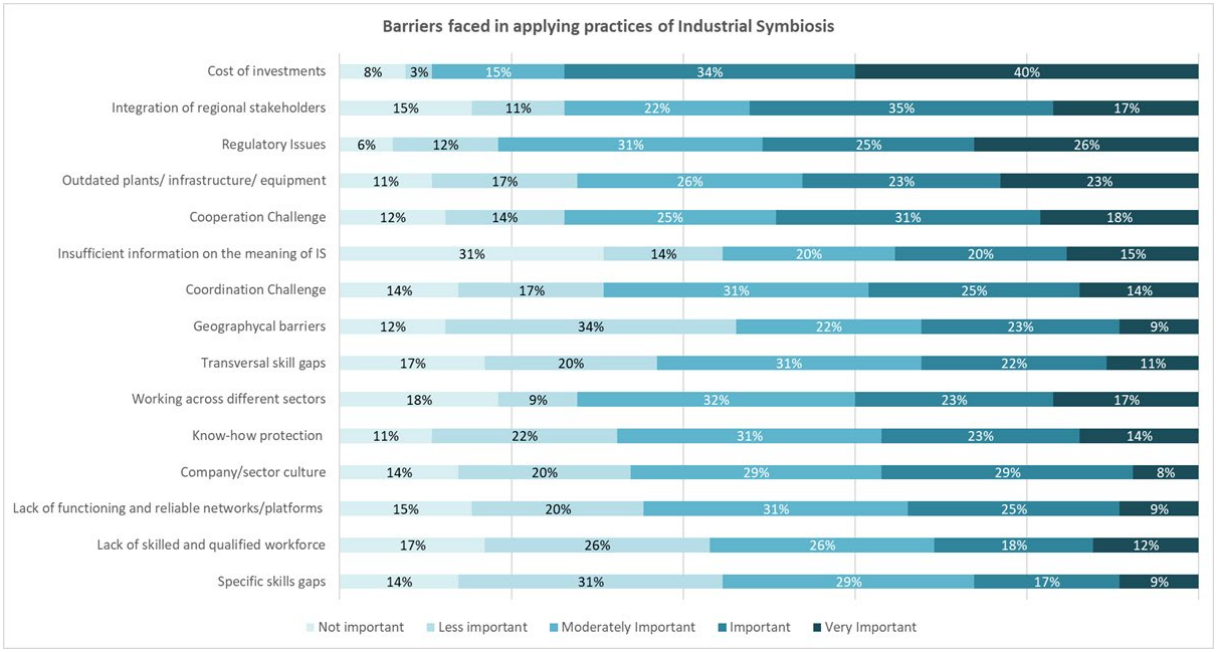
DIRECT JOBS 	47500	**PRODUCTION (€)** 	15 bn
ENERGY 	To extract and process minerals there is need for energy and fuels. The sector has demonstrated via the various Life Cycle Inventories that the energy consumption and the carbon footprint are reduced over the years.		
EMISSIONS 	The process emissions especially for the minerals that have a calcination step can be mitigated using CCS or CCU (Carbon Capture and Storage and Utilization, respectively). The natural carbonation in lime sector has demonstrated that can reduce in average 33% of the process emissions during the use phase based on a recent study conducted by PoliMI.		
WASTE 	Most of the mining waste is used as top-soil in restoration activities. By-products from the mineral processing can be feedback into the process or valorised in other applications Most end-of life minerals are embedded in various applications where they are used (i.e. construction, glass, plastic, water purification, steel, paper, …). The recycling of these applications when they meet the quality criteria, will reduce to some extend the pressure for primary raw materials and contribute to circularity practices. However important to stress is that, the recycling alone will be insufficient to supply demand for minerals.		
RAW MATERIALS 	Due to the enabling role of minerals in multiple sectors, the access to industrial minerals from EU is a key factor regarding mineral sector competitiveness		

INDUSTRIAL SIMBIOSYS (IS)	A very extended example of IS in the minerals sector is the production of precipitated Calcium Carbonate (PCC) within paper mills as part of the so known satellite plants. The satellite plants that account for around 80% of operations in EU, deliver on IS principles as they avoid transport and result in resource optimisation thanks to tailored dosing. Other example is the use of recycling of gypsum via the Flue Gas Treatment (FGT) with lime/GCC in coal fired plants. The gypsum from this route supplies for 60% of demand in Germany and around 50% across EU.
REFERENCES	Spire, 2021, IMA Roadmap (2014); IMA recycling sheets (2018); IMA Minerals Contribution to Circular Economy (2018); EuLA Innovation report (2018); EuLA Carbonation study (2021).

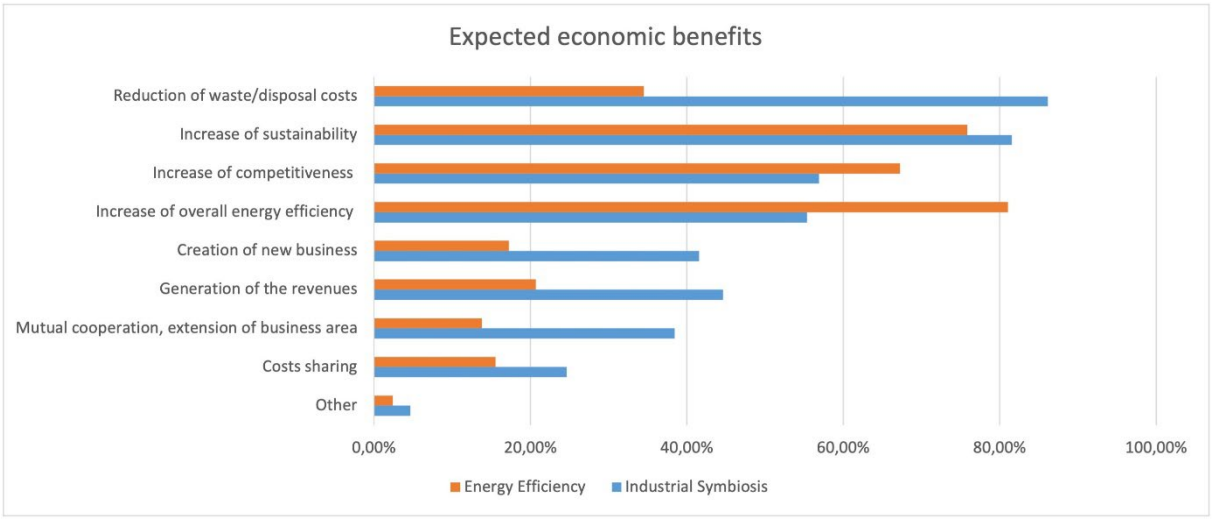
8.5 *Detailed Figures*

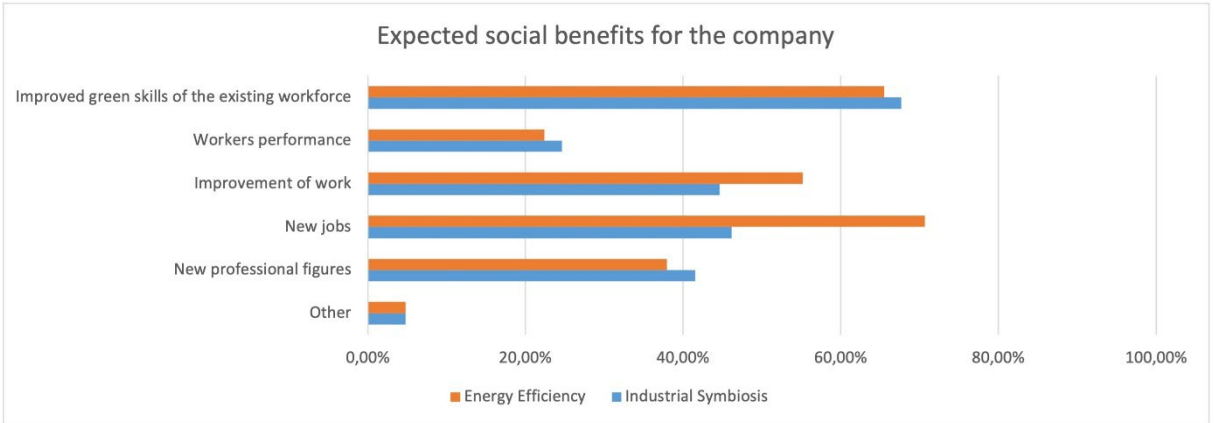
8.5.1 Barriers Faced in EE and IS





8.5.2 Expected economic and social benefits





8.5.3 Skill assessment (example Energy Manager)

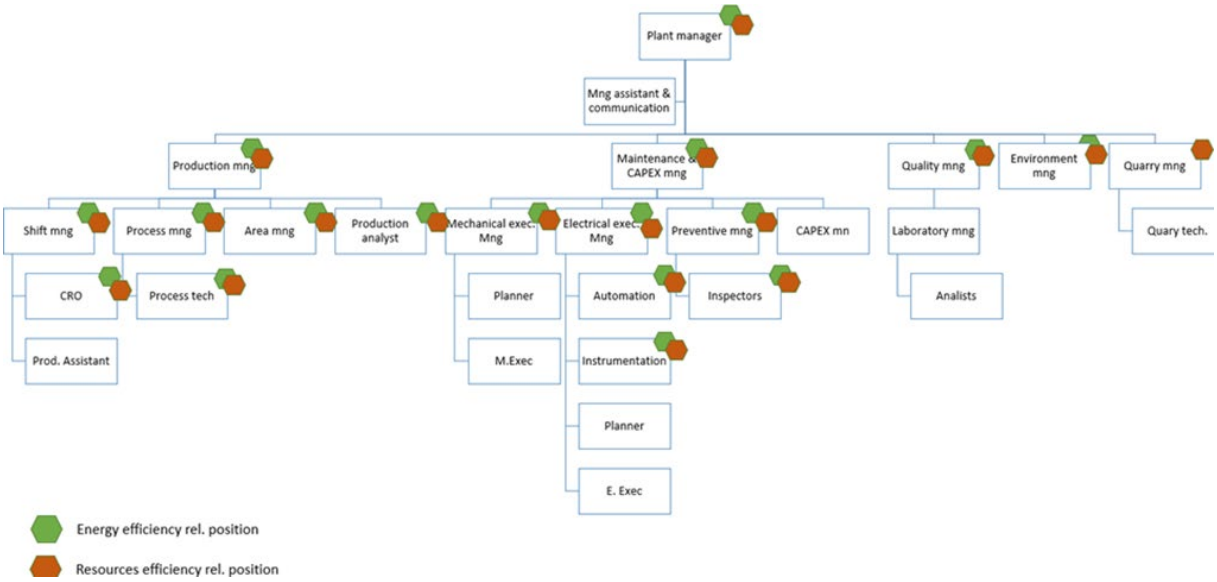
PROFILE TITLE	Energy Manager		
ISCO Code	1349.12		
Mission	Energy managers coordinate the energy use in an organisation, and aim to implement policies for increased sustainability, and minimisation of cost and environmental impact.		
TASKS	Current	Future	
Main task/s	adhere to organisational guidelines advise on systems energy efficiency advise on utility consumption analyse energy consumption carry out energy management of facilities compose energy performance contracts conduct energy audit adhere to organisational guidelines develop energy policy develop manufacturing policies manage staff manage supplies promote environmental awareness promote innovative infrastructure design promote sustainable energy promote sustainable management supervise daily information operations	(here it should be listed, which tasks are changing/modified in which way, and if new tasks appear)	
Equivalent profiles	energy and sustainability manager energy procurement manager energy policy manager energy monitoring manager		
SKILLS		Current Level	Future Level
Technological skills			
Industrial Symbiosis skills	IS basic understanding		
	System optimisation & process analysis		
	Field experience (in IS)		
	Product life cycle thinking assessment		
	Sustainable resource management		
Energy efficiency	Understanding energy use & costs		
	Energy management of equipment and parts		
	System optimisation & process analysis		
	Energy data collection & analysis		
	Field experience (in EE)		
SKILLS		Current Level	Future Level
Transversal skills			
Individual, personal skills	Environmental awareness		
	Collaboration		
	Entrepreneurship and initiative taking		
	Complementary, systematic, critical thinking		
	Creativity		
Regulatory skills	General regulatory awareness		
	Legislation on waste & energy management & CO2 emissions		
Business related skills	Business knowledge		
	Identification of potential opportunities		
	Fostering cooperation		

8.5.4 Skills assessment (example Liquid Waste Treatment Operator)

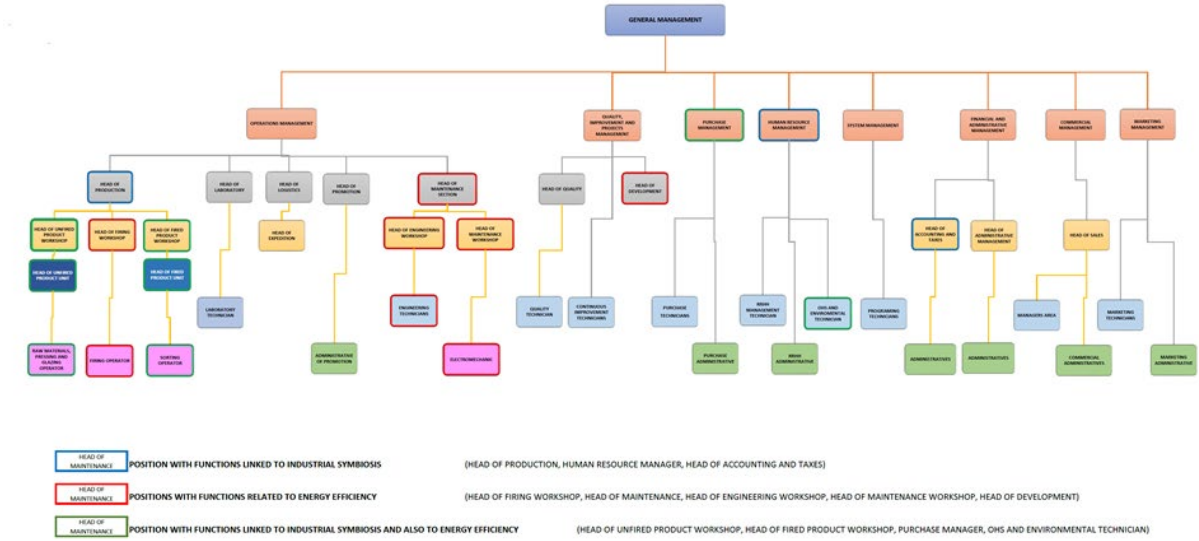
PROFILE TITLE	Waste Management Technician (Liquid Waste Treatment Plant Operator		
ISCO Code	3132.2		
Mission	Liquid waste treatment technicians remove hazardous chemicals and pollutants from liquid waste such as oil so that it can be safely used for new applications. They operate and maintain liquid waste treatment equipment, monitor operations, and test samples to ensure the safety standards are met.		
TASKS	Current	Future	
Main task/s	analyse experimental laboratory data document analysis results drain hazardous liquids ensure compliance with environmental legislation handle chemicals handle waste measure density of liquids perform laboratory tests perform water treatments test chemical samples	(here it should be listed, which tasks are changing/modified in which way, and if new tasks appear)	
Equivalent profiles	liquid waste treatment plant worker liquid waste plant monitoring operator liquid waste tester liquid waste treatment plant operative liquid waste treatment plant operator		
SKILLS		Current Level	Future Level
Technological skills			
Industrial Symbiosis skills	IS basic understanding		
	System optimisation & process analysis		
	Field experience (in IS)		
	Product life cycle thinking assessment		
	Sustainable resource management		
Energy efficiency	Understanding energy use & costs		
	Energy management of equipment and parts		
	System optimisation & process analysis		
	Energy data collection & analysis		
	Field experience (in EE)		
SKILLS		Current Level	Future Level
Transversal skills			
Individual, personal skills	Environmental awareness		
	Collaboration		
	Entrepreneurship and initiative taking		
	Complementary, systematic, critical thinking		
	Creativity		
Regulatory skills	General regulatory awareness		
	Legislation on waste & energy management & CO2 emissions		
Business related skills	Business knowledge		
	Identification of potential opportunities		
	Fostering cooperation		
	Business model transformation		
	Project planning and management		

8.6 *Sectoral Organisational Flowcharts*

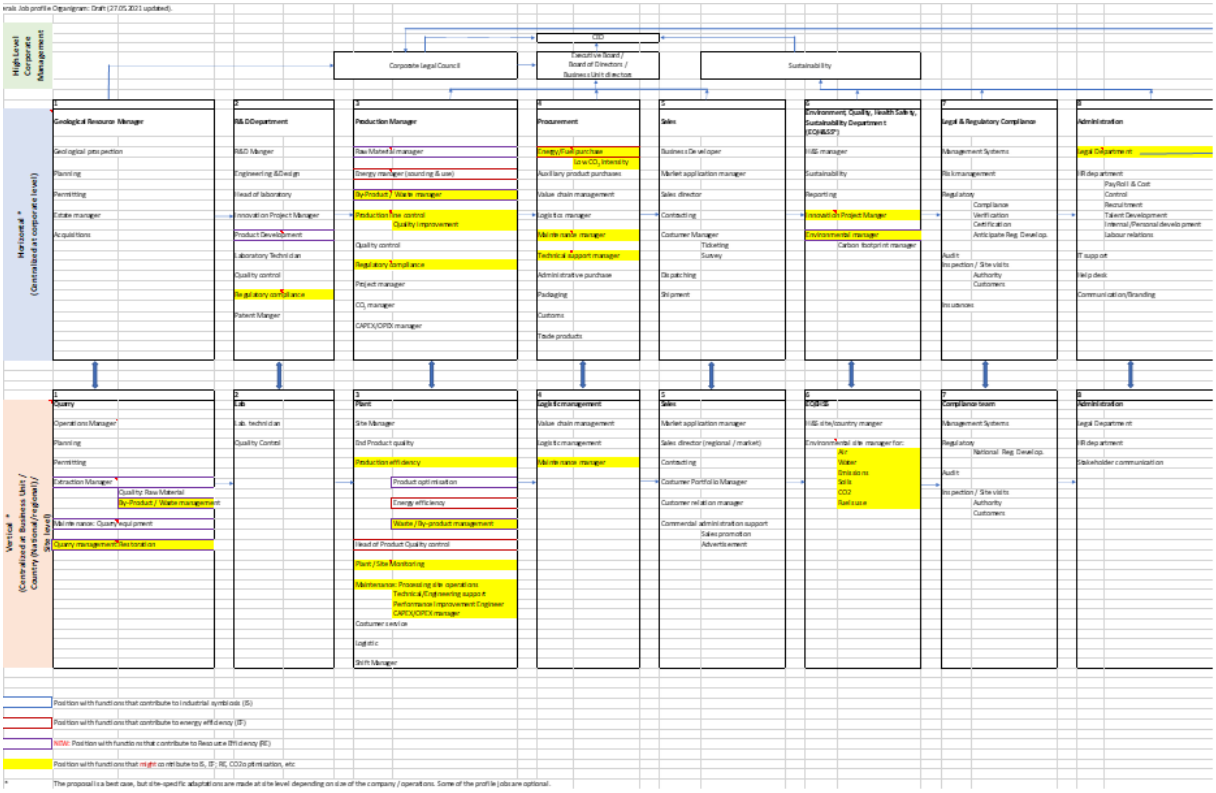
8.6.1 Cement



8.6.2 Ceramics

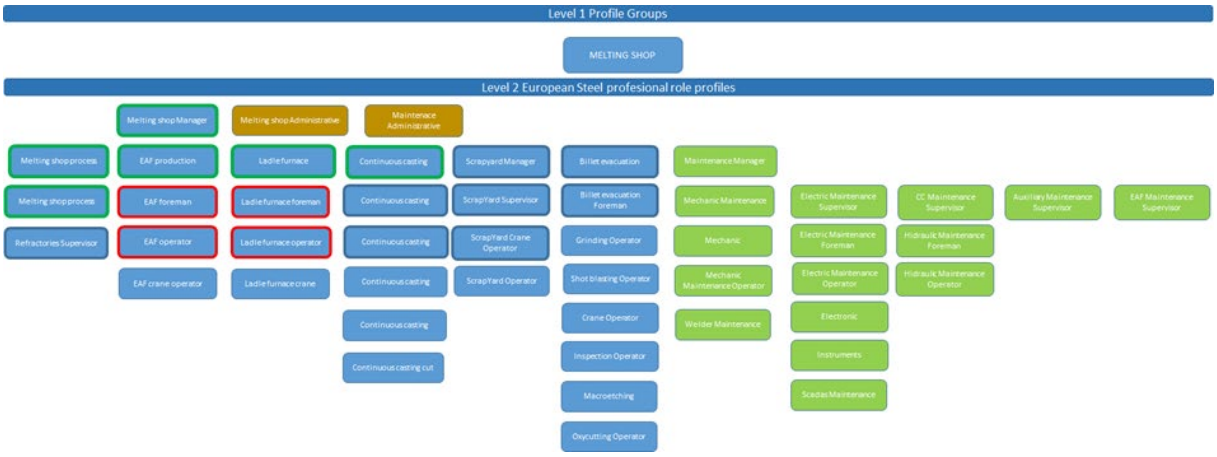


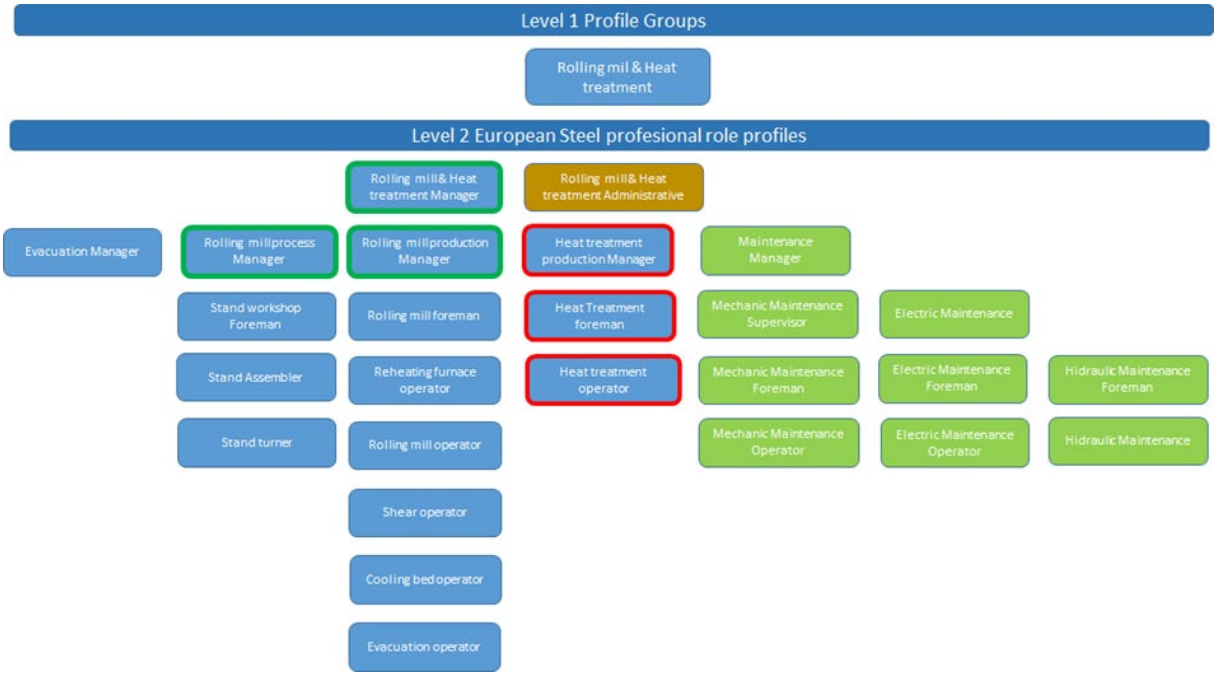
8.6.3 Minerals

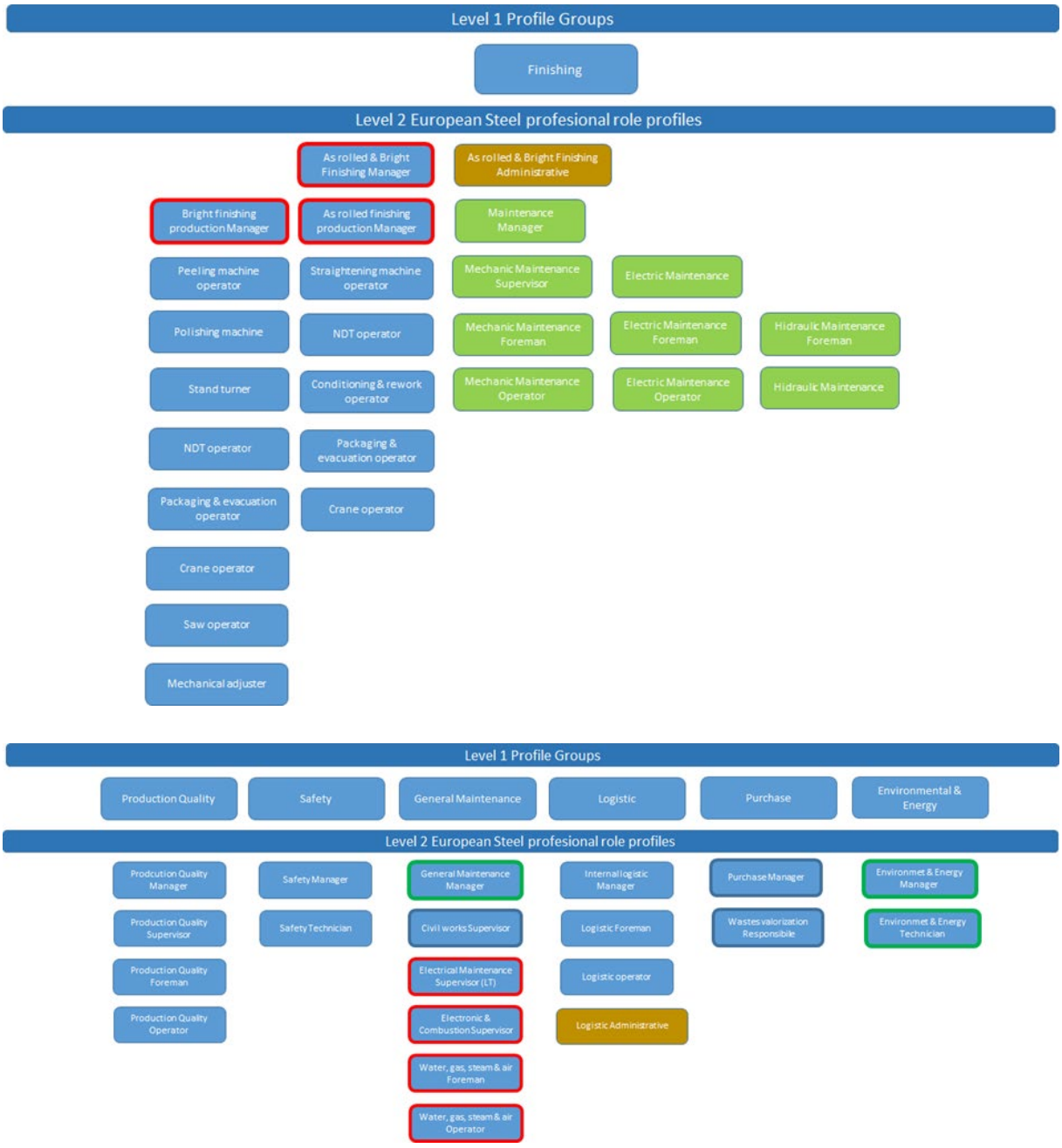


8.6.4 Steel

Green Framed Job Profiles	related to IS
Red Framed Job Profiles	related to EE
Blue Framed Job Profiles	related to both IS and EE

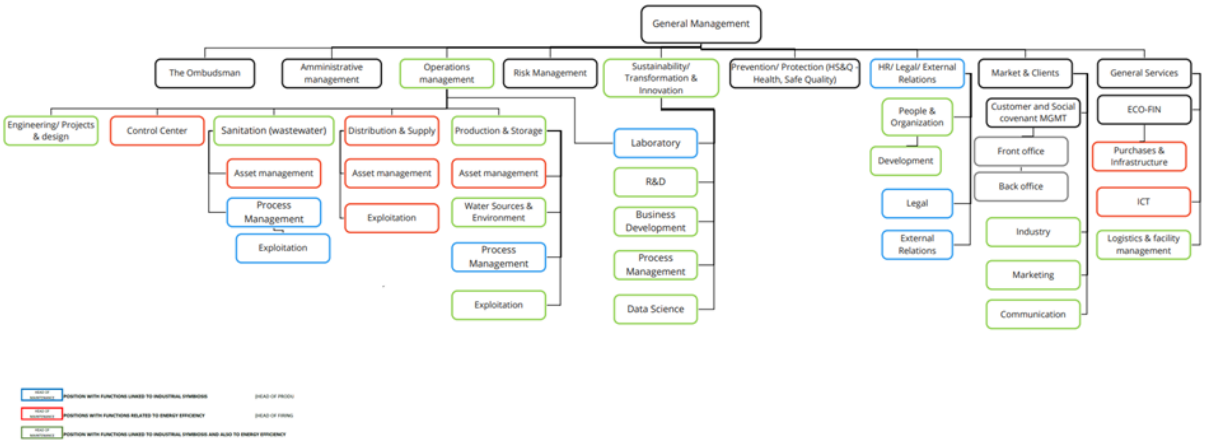

Level 1 Profile Groups
MELTING SHOP
Level 2 European Steel profesional role profiles
Melting shop Manager
Melting shop Administrative
Maintenace Administrative
Melting shop process
EAF production
Ladle furnace
Continuous casting
Scrapyard Manager
Billet evacuation
Maintenance Manager
Melting shop process
EAF foreman
Ladle furnace foreman
Continuous casting
Scrapyard Supervisor
Billet evacuation Foreman
Mechanic Maintenance
Electric Maintenance Supervisor
CC Maintenance Supervisor
Auxiliary Maintenance Supervisor
EAF Maintenance Supervisor
Refractories Supervisor
EAF operator
Ladle furnace operator
Continuous casting
Scrapyard Crane Operator
Grinding Operator
Mechanic
Electric Maintenance Foreman
Hidraulic Maintenance Foreman
EAF crane operator
Ladle furnace crane
Continuous casting
Scrapyard Operator
Shot blasting Operator
Mechanic Maintenance Operator
Electric Maintenance Operator
Hidraulic Maintenance Operator
Continuous casting
Crane Operator
Welder Maintenance
Electronic
Continuous casting cut
Inspection Operator
Instruments
Macroetching
Scadas Maintenance
Oxycutting Operator


Level 1 Profile Groups
Rolling mil & Heat treatment
Level 2 European Steel profesional role profiles
Rolling mill& Heat treatment Manager
Rolling mill& Heat treatment Administrative
Evacuation Manager
Rolling millprocess Manager
Rolling millproduction Manager
Heat treatment production Manager
Maintenance Manager
Stand workshop Foreman
Rolling mill foreman
Heat Treatment foreman
Mechanic Maintenance Supervisor
Electric Maintenance
Stand Assembler
Reheating furnace operator
Heat treatment operator
Mechanic Maintenance Foreman
Electric Maintenance Foreman
Hidraulic Maintenance Foreman
Stand turner
Rolling mill operator
Mechanic Maintenance Operator
Electric Maintenance Operator
Hidraulic Maintenance
Shear operator
Cooling bed operator
Evacuation operator


Level 1 Profile Groups
Finishing
Level 2 European Steel profesional role profiles
As rolled & Bright Finishing Manager
As rolled & Bright Finishing Administrative
Bright finishing production Manager
As rolled finishing production Manager
Maintenance Manager
Peeling machine operator
Straightening machine operator
Mechanic Maintenance Supervisor
Electric Maintenance
Polishing machine
NDT operator
Mechanic Maintenance Foreman
Electric Maintenance Foreman
Hidraulic Maintenance Foreman
Stand turner
Conditioning & rework operator
Mechanic Maintenance Operator
Electric Maintenance Operator
Hidraulic Maintenance
NDT operator
Packaging & evacuation operator
Packaging & evacuation operator
Crane operator
Crane operator
Saw operator
Mechanical adjuster

Level 1 Profile Groups
Production Quality
Safety
General Maintenance
Logistic
Purchase
Environmental & Energy
Level 2 European Steel profesional role profiles
Prodcution Quality Manager
Production Quality Supervisor
Production Quality Foreman
Production Quality Operator
Safety Manager
Safety Technician
General Maintenance Manager
Civil works Supervisor
Electrical Maintenance Supervisor (LT)
Electronic & Combustion Supervisor
Water, gas, steam & air Foreman
Water, gas, steam & air Operator
Internal logistic Manager
Logistic Foreman
Logistic operator
Logistic Administrative
Purchase Manager
Wastes valorization Responsible
Environmet & Energy Manager
Environmet & Energy Technician

8.6.5 Water



8.6.6 Chemical