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

Prototype of the Blueprint New Skills Agenda Energy Intensive Industries

Deliverable D5.2

(Status: 30.12.2021)

Project acronym:	SPIRE-SAIS
Project title:	Skills Alliance for Industrial Symbiosis: A Cross-sectoral Blueprint for a Sustainable Process Industry
Project number:	612429-EPP-1-2019-1-DE-EPPKA2-SSA-B
Coordinator:	TU Dortmund University (TUDO)
Funding Scheme:	Erasmus+
Due date of deliverable:	December 2021
Actual submission date:	30th of December 2021
Project duration:	01.01.2020 – 31.12.2023 (48 months)
Work package:	WP 5 – European Blueprint
Work package leader:	TU Dortmund University
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Dissemination level:	Public

Co-funded by the Erasmus+ Programme of the European Union

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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 (common) market solutions, business and cooperation models (for reducing production costs, implementing new jobs, and including external customers). Additionally, 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 (EE) 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 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 simplify energy cooperation/services at all governance levels are in place as well.

Related to 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 IS and EE implementation. The pro-active skills strategy has to consider technical as well as soft skills for mainly incremental and complementary *upskilling of existing occupations and job profiles*, taking also into account *additional job profiles* (such as the IS Facilitator). Skills demands for Energy Efficiency have a lower level than for Industrial Symbiosis (higher demand). Managerial (business and regulatory) and operational skills (technical, transversal/individual) are needed.

Against this background, industry driven skills demands were defined by the sector associations and companies involved in SPIRE-SAIS by examine the range of essential Job Profiles and skills, knowledge and experience that workers need to adopt energy efficiency and industrial symbiosis in daily work in the different industry 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, equivalencies with occupations of the ESCO database and ISCO groups were identified, while related skills were selected and grouped to a sector overarching *skills classification* added by a first skills *assessment template*.

Important results and impact for the Blueprint from the VET Perspective are the low educators' readiness for teaching green skills effectively, a poor evidence base to assess and replicate good practices and courses, a missing cross-sectoral IS/EE module to be integrated in different occupational trainings, including didactic materials and guidance for education providers, as

well as a uniform skills recognition system. Another important barrier is the lack of a coherent policy: fragmentation of the responsibility for green skills delivery and a missing 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 used in the SPIRE-SAIS project 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 mostly useful to the representatives of the industry *and* VET providers (e.g. interlinking circular job profiles with national occupations).

The SPIRE-SAIS Blueprint is taking up these results by the establishment of a Skills Intelligence Hub including a Foresight Observatory and a 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 will be defined in an Open Coordination way, dividing responsibilities between the main and willing actors. Within the *Foresight Observatory* technology and skills foresight will be done on a regular basis, among other activities via a (bi-)annual survey "*Industrial Symbiosis Technology and Skills Radar".* Recommendations, self-assessment tools, indicators and incentives will be developed pushing the focus on qualifications, competences and skills for Industrial Symbiosis and Energy Efficiency. A repository will give an overview about IS and EE relevant research and education projects, pilot measures and test possibilities will be supported, including looking for (European and national) funding schemes. An Online Training Platform will be established, as well as the coordination of industry image campaigns for recruitment and talent attraction.

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 European Countries from Northern, Eastern, Western and Southern Europe. However, via its sector associations we cover all the European Member States with Energy Intensive Industries. This ensures a European-wide rollout of the SPIRE-SAIS Blueprint engaging with national VET systems and cross-sector 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 2020 Public Private Partnership SPIRE (www.spire2030.eu/) with more than 140 members (companies, training providers, research institutes) encompassing and coordinated by A.SPIRE, the co-leader of SPIRE-SAIS.

SPIRE-SAIS Blueprint is not planned as a stand-alone solution. The Blueprint strategy is led by a cooperative and division of responsibilities and leadership approach. Therefore, the SIHub and the European IS Training Community will be aligned or support European activities related to European Energy Intensive Industries:

- 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
- Central stakeholder groups (social partners, sector associations and unions, policymakers, education system players, etc.)
- The planned CSA European Community of Practice for Industrial-Urban Symbiosis and Regional Hubs for Circularity and Industrial Urban Symbiosis

- 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; CEDEFOP Skills Intelligence Platform; European Skills, Competence, and Occupation Database (ESCO)

In this sense, 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.*

SPIRE-SAIS is aiming at establishing a European Training Platform connected with or integrated in the forthcoming European Community of Practice (ECoP) integrating training for hubs for circularity (H4C). Within its European Training Platform for proactive skills assessment and adjustments an effective and sustainable forum will analyse continuously and proactively skills gaps. The Online Training Platform will provide up-to-date support and knowledge to energy intensive industries by collecting and developing up to date training modules and tools, related to the H4C regions in Europe. We are looking at 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 regions with H4C not only for exchanging tools and knowledge across regions is guaranteed, but also mutual learning, not reinventing the wheel several times new.

Together with the ECoP, suitable European regions for the SPIRE-SAIS Blueprint Rollout strategy will be identified, reaching out for high Symbiosis Readiness Levels (SRL) based on skills, competences and qualifications. Within a comprehensive concept, we aim at an interplay between actors from different industry sectors at local, regional, national and European level. 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 (including learning arrangements for solving technical and non-technical problems; improving the capabilities of the enablers/facilitators of Industrial Symbiosis and Energy Efficiency).

Due to the cyclic concept and social innovation process of SPIRE-SAIS, all the existing elements, deliverables, tools, and measures will be further developed and improved by new insights. Databases and repositories will be added with new elements within the next years (2022/23). Namely a further job profile related skills assessment (skills gaps, current and future proficiency levels) and a job profile database improvement (connected with ESCO/ISCO occupations and the related VET database) will take place.

Within the first implementation and testing phase 2022, the necessary parameters for a sustainable integration and alignment of SPIRE-SAIS and its main elements (SIHub and Training Platform) within the described existing European and national/regional structures will be elaborated, establishing interrelated Alliances and Leadership on the European and sectoral level, fostering joint Blueprint activities and setting the ground for a national/regional rollout.

Special attention has the organisational integration and sustainable running of the Training Platform. Furthermore, we will examine in how far the pilot training tools, measures and arrangements are reaching out to the target groups, in how far they have to be improved, adjusted or (if necessary) generally changed. Within this test environment, additional, more specific and further needed training offers will collected and integrated, including didactical measures combining on the job with online training.

The Skills Intelligence Hub for Industrial Symbiosis (SIHub) will bundle all the necessary activities to (a) monitor and evaluate regularly technological and economic developments and related industry skills requirements for Industrial Symbiosis (Foresight Observatory, Technology and Skills Radar) and (b) to ensure the alignment and support the European IS Training Community, engaging and supporting companies, training and education providers, associations and social partners, public education authorities to *find their place in the SPIRE-SAIS Skills Alliance*.

For the test and rollout phase 2022/23, an implementation (Deliverable D6.1) and exploitation plan (Deliverable D6.3) will be developed setting the ground for the sustainability of the Blueprint Alliance and gathering first experiences of rollout strategies and possibilities at sectoral, national and regional level. Beside the European (SPIRE and its sector associations) the regional level in line with the ECoP and Hubs for Circularity of the new SPIRE program “Processes for Planet” will be of high relevance for SPIRE-SAIS.

1 Introduction

This description of the SPIRE-SAIS Blueprint Prototype is based on the project results concerning technological developments, industry skills requirements, Vocational Education and Training System (VET) support, and first outlines of a training framework (incl. upskilling schemes and training offers) 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, we will integrate the outcomes so far in a common picture (Prototype). Reflecting the background and its programmatic orientation, the Blueprint Prototype will outline its relevant elements and related strategies, tools, implementation and rollout concept.

1.1 Background

In line with the European New Skills Agenda, the Pact for Skills and the series of Sectoral Blueprints the main objective of the project is to develop 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* starting a (social) innovation process by involving a broad range of key stakeholders from the eight sectors of the public-private partnership 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 sector 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) they are engaged in. Up to now 13 associated partners are joining the 24 partners of the consortium, showing the high interest of the industries and setting the ground for addressing industry sectors overarching skills 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 Key Performance Indicators (KPIs), 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 SPIRE 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 and up-to-date setting for implications for the following work packages on industry skills requirements and VET system contexts and support is guaranteed. 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 are elaborated and dissemination activities are planned and conducted. Within a social innovation process including two iteration cycles the Blueprint *Prototype* will be implemented and tested in 2022 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) will be updated with new developments, all in all leading to an improved Blueprint which will be finalised in 2023.

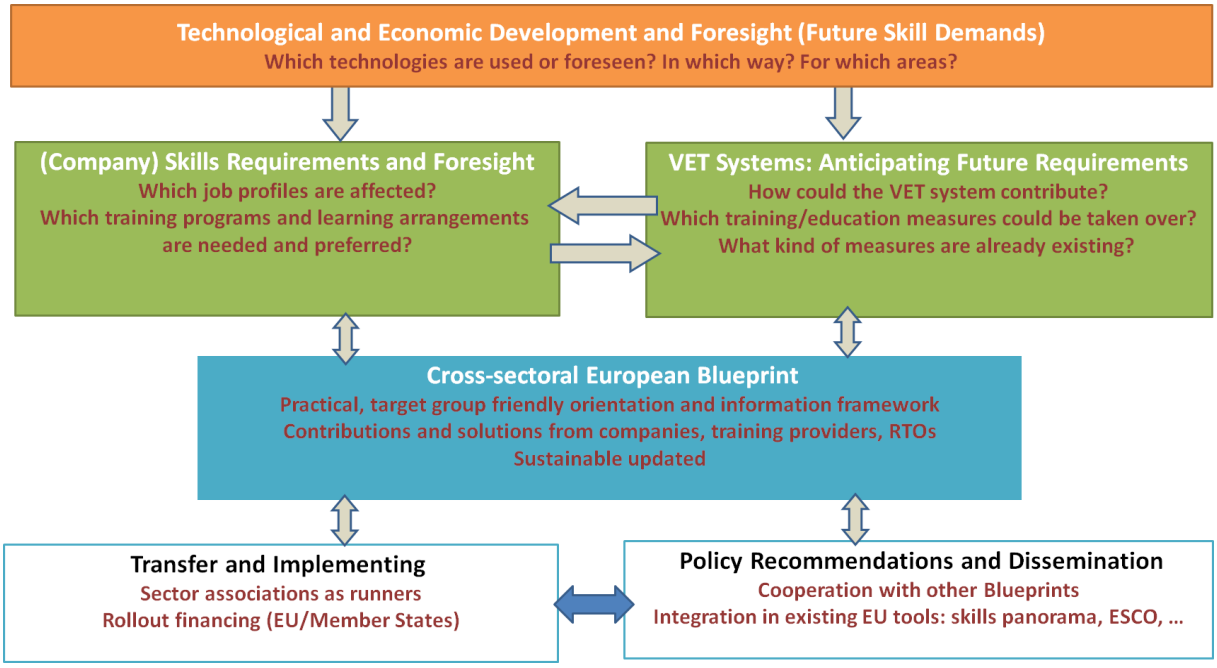


Figure 1: Structure and Work Programme of SPIRE-SAIS.

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 (European Commission 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." (European Commission 2021, p.14)

Against this backdrop, skills are seen as an important **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 sector overarching* Blueprint so far is developing a common Blueprint Prototype focusing on a *cross-sectoral perspective of new or updated skills for industrial symbiosis and energy efficiency* by combining the demand with the supply and coordination of skills adjustment:

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

- Observing continuously (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)
- Aligned to 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:
    1. Establishing a Skills Intelligence Hub (SIHub) with a Foresight Observatory and Survey (Industrial Symbiosis Technology and Skills Radar) (section 3.1)
    2. Creating a training platform for (new) training offers and appropriate learning arrangements (see D5.1; Almeida et al., 2021), including (section 3.2):
        1. a repository or exchange platform of training courses for Industrial Symbiosis and related Energy Efficiency
        2. 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)
        3. incentives and/or awards for generating good/best practice
    3. 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 SPIRE coordination and sector structures* (A.SPIRE, sector associations, social partnership), assigning leadership for the specific elements of the Blueprint on the European (cross-sectoral and sectoral) and national/regional level (sectoral, Hubs for Circularity). This will lead to improving the level of cooperation between associations and social partners, companies, training providers and other stakeholder groups for fostering 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 will seek a close cooperation with the planned European Community of Practice (ECoP) for Industrial Symbiosis and Hubs for Circularity, by bringing in our Human Resources and Skills perspective.
  With this collaboration we are looking for combining the European SPIRE-SAIS activities with the most important Hubs for Circularity on the regional level.
  Additionally, we will integrate the Blueprint in relevant activities on the European level (New Skills Agenda, Pact for Skills, Cedefop's Skills Panorama and Skills Intelligence Platform, and others). Beside the planned European-Regional cooperation within the ECoP the further roll-out of the Blueprint is concentrating on sector associations, including VET system support of the member states, done in a common action with the Pact for Skills and other sectoral industry Blueprints (batteries, steel, automotive, construction, and others), as far as this is feasible and possible.

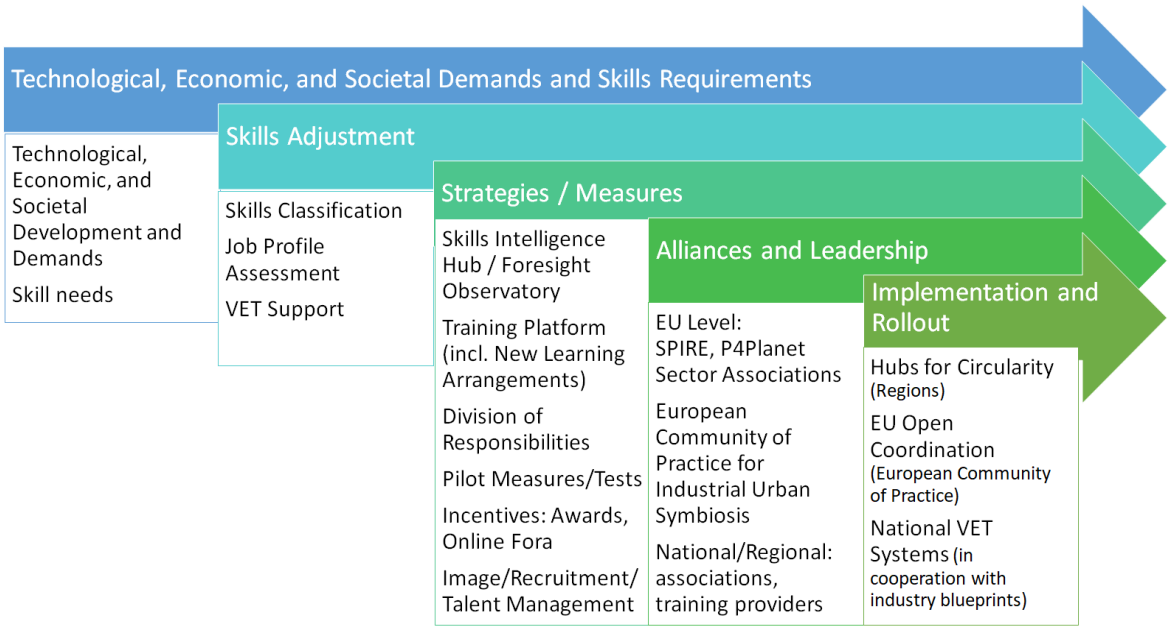


Figure 2: Outline of the SPIRE-SAIS Blueprint

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 organisation implications. The triangle of **technology - organisation - human** is the frame for defining the new skills needs. The supply side is reflecting (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 ground for a better industry image and attractiveness and basic industrial skills has to be uptaken as early as possible by pre-VET education (Kindergarten, primary and secondary schools).

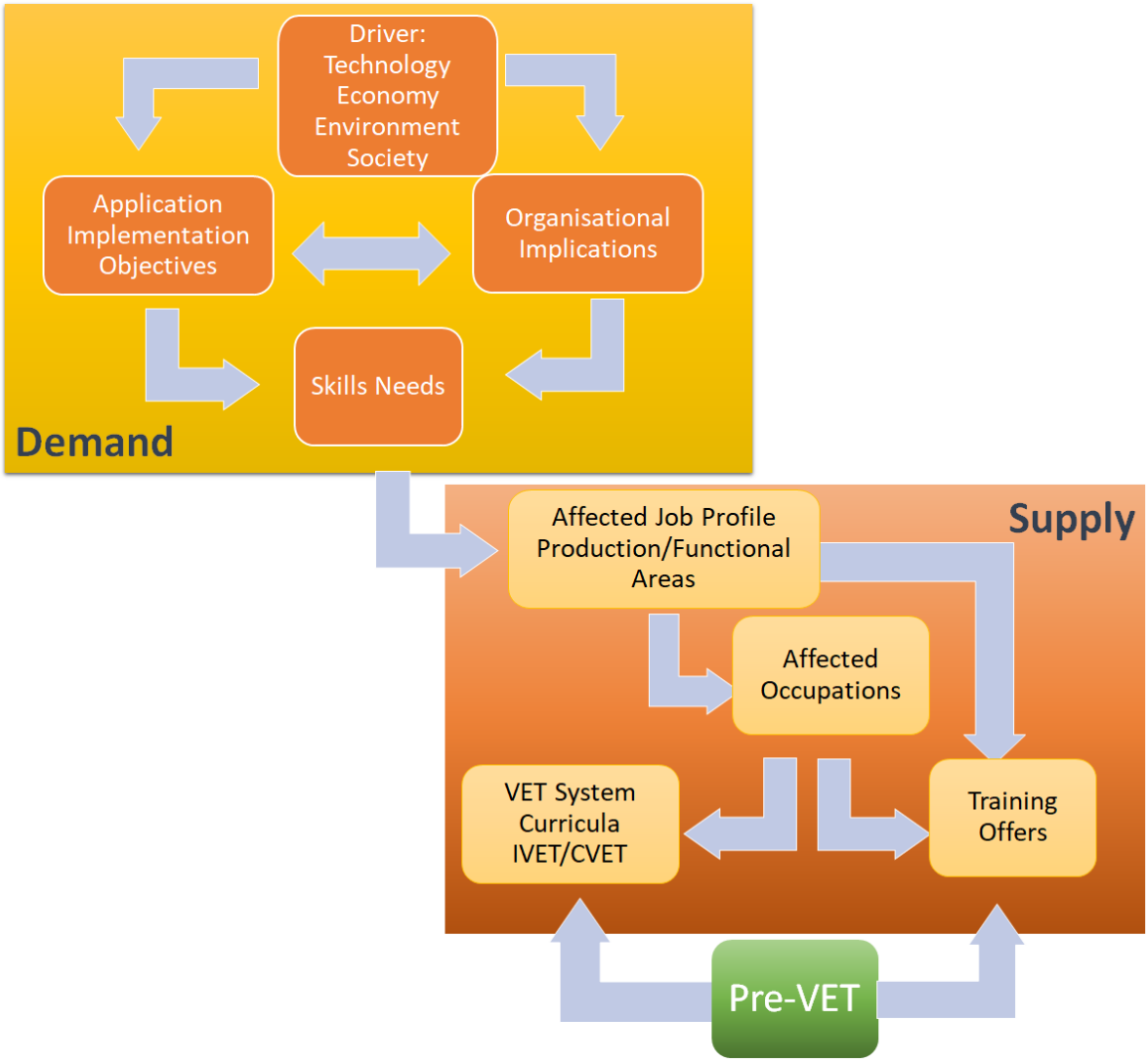


Figure 3: Demand and Supply Side

To ensure sustainability of SPIRE-SAIS and the integration of the different sector perspectives, the process of developing and implementing the Blueprint is organised as a *social innovation process*, integrating 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 sectoral Blueprint funded by the Erasmus+ program was taken up, leading 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 (steel 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. Because of changing social practices, such a social innovation is not expecting a linear development process, **iterative and cyclical feedback loops** are planned and taken into account, ensuring an upgrading of the interventions and implementation of the Blueprint (see figure below).

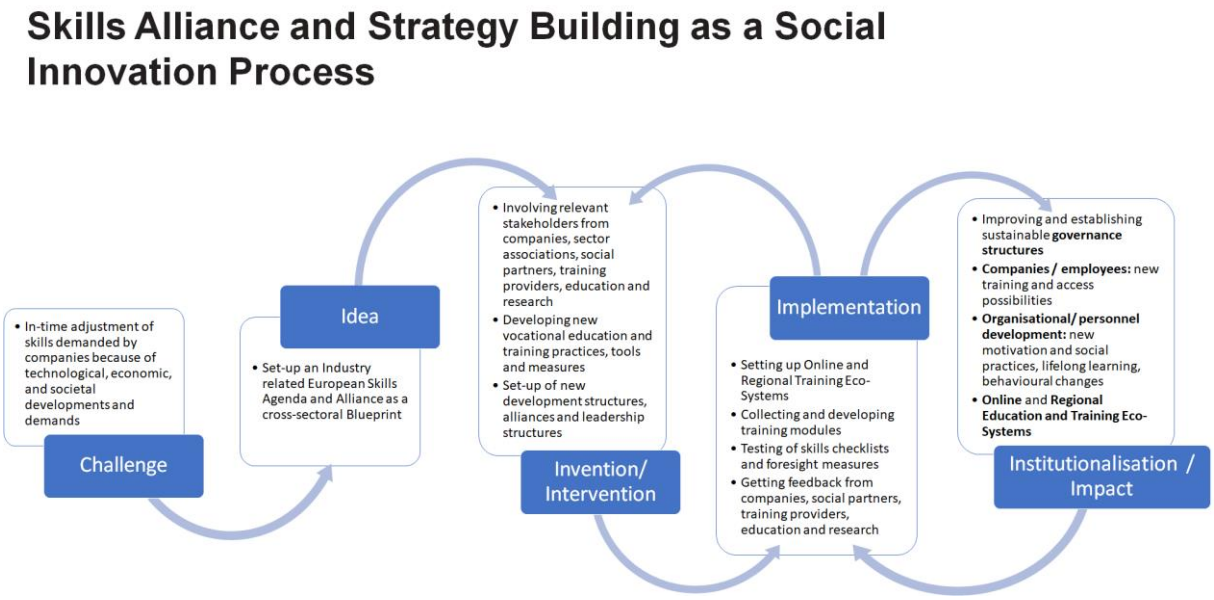


Figure 4: Blueprint Development and Implementation as a Social Innovation Process

2 The Demand Side: Industry Driven Skills Demands

As already described in the beginning and shown in Figure 3, SPIRE-SAIS is looking at the demand and supply side for skills adjustment. 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.

2.1 Technological and Economic Demands and Skills Requirements

The analysis (see in detail D2.1; SPIRE-SAIS, 2021) 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 if integrated in the documents, also including training/education projects: Generally providing a first basis for a complete state-of-the-art on IS and EE implementation in 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 and its Prototype.

2.1.1 Technological development

Industrial symbiosis is aiming 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 involved symbiotic transactions include: waste utilisation 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 in achieving higher results in the 4R (Reduce, Reuse, Recycle and Restore) approach for waste management. The creation of synergies among companies can allow developing successfully industrial symbiosis as well as providing benefits to all parties. In this process, companies develop a trust bond facilitating the supply resources. On the other hand, implementation of the symbiosis network can also produce some problems for companies. Synergies involved by 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 ongoing 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 for the reduction of energy utilization and environmental impact, and cost savings. Case studies and projects have been shown the methods for energy analysis and optimization, by analysing the suitability of energy strategies within Energy Intensive Sectors. As sources of energy losses considered as a waste for a company could 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 shown in some cases, such as the steel sector, by the reduction of 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. For instance, in the steel sector, 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 but also (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, 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 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 governance levels are in place as well.

2.1.2 Workforce Development

Related to 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 IS and EE implementation. The pro-active skills strategy has to consider technical as well as soft skills for:

- **Industrial Symbiosis skills**: communication and information, co-creation and cooperation with other sectors and local stakeholders and authorities, managing diversity to involve different stakeholders, materials and recycling know-how, fostering financially attractive paths with a strong positive impact on the environment.
- **Creating IS facilitator** profiles: esp. new skills for networking, collaboration, system thinking, legislation (environmental economics & policy), special 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 to manage 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

Additional to the desk research, the *company survey* across the different sectors (see in detail D2.1; SPIRE-SAIS, 2021, pp. 121) 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 5).

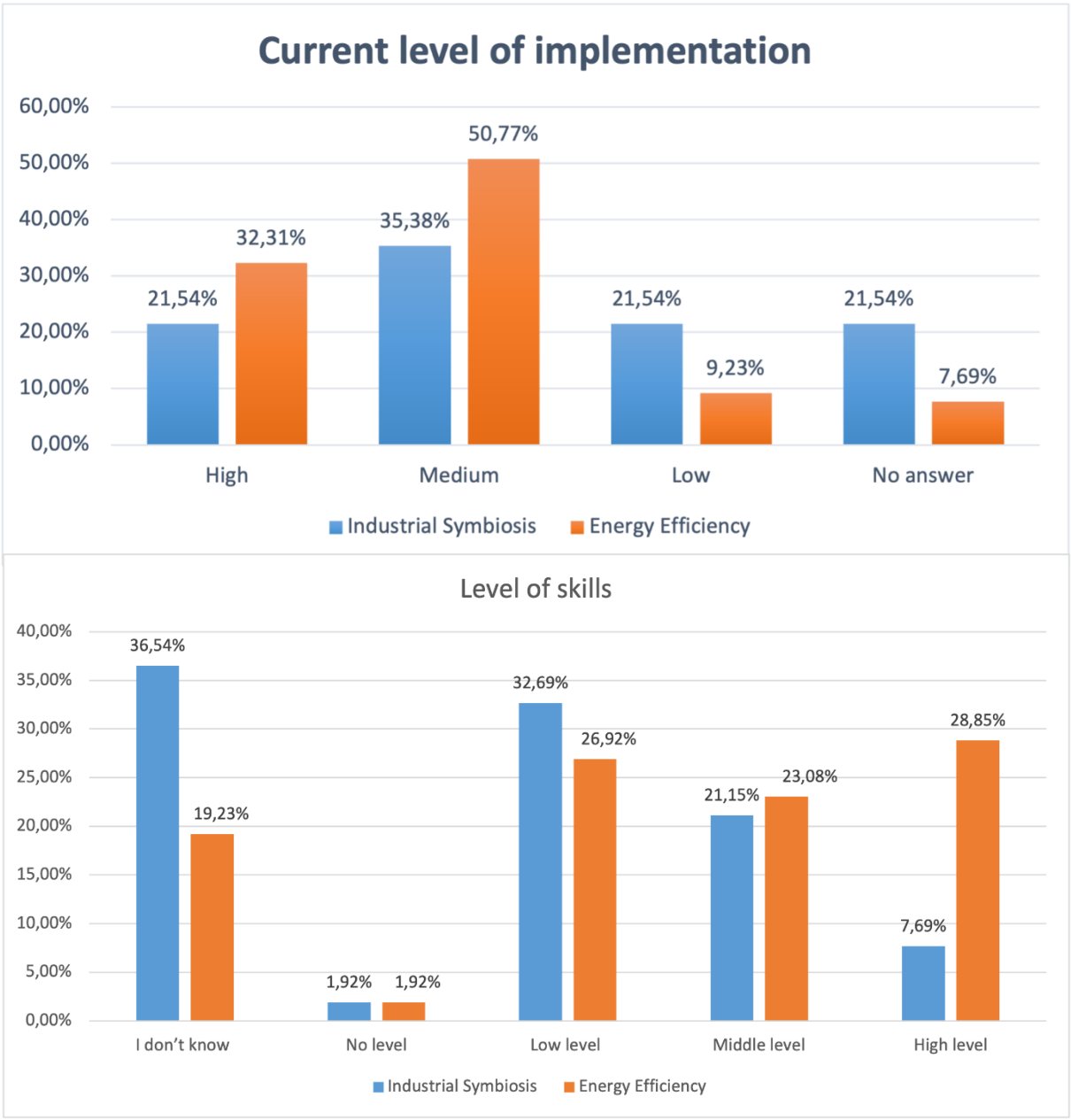


Figure 5: Technological Implementation and Level of Skills

By implementing industrial symbiosis and energy efficiency the company 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* belonging to implementation practices and perception of solutions and the generation of new skill demands in any category of workers. Main barriers are cost of investments, working across different sectors, integration of regional stakeholders, regulatory issues, outdated plants, infrastructure and equipment, cooperation challenges, and skills gaps (see Figure 6).

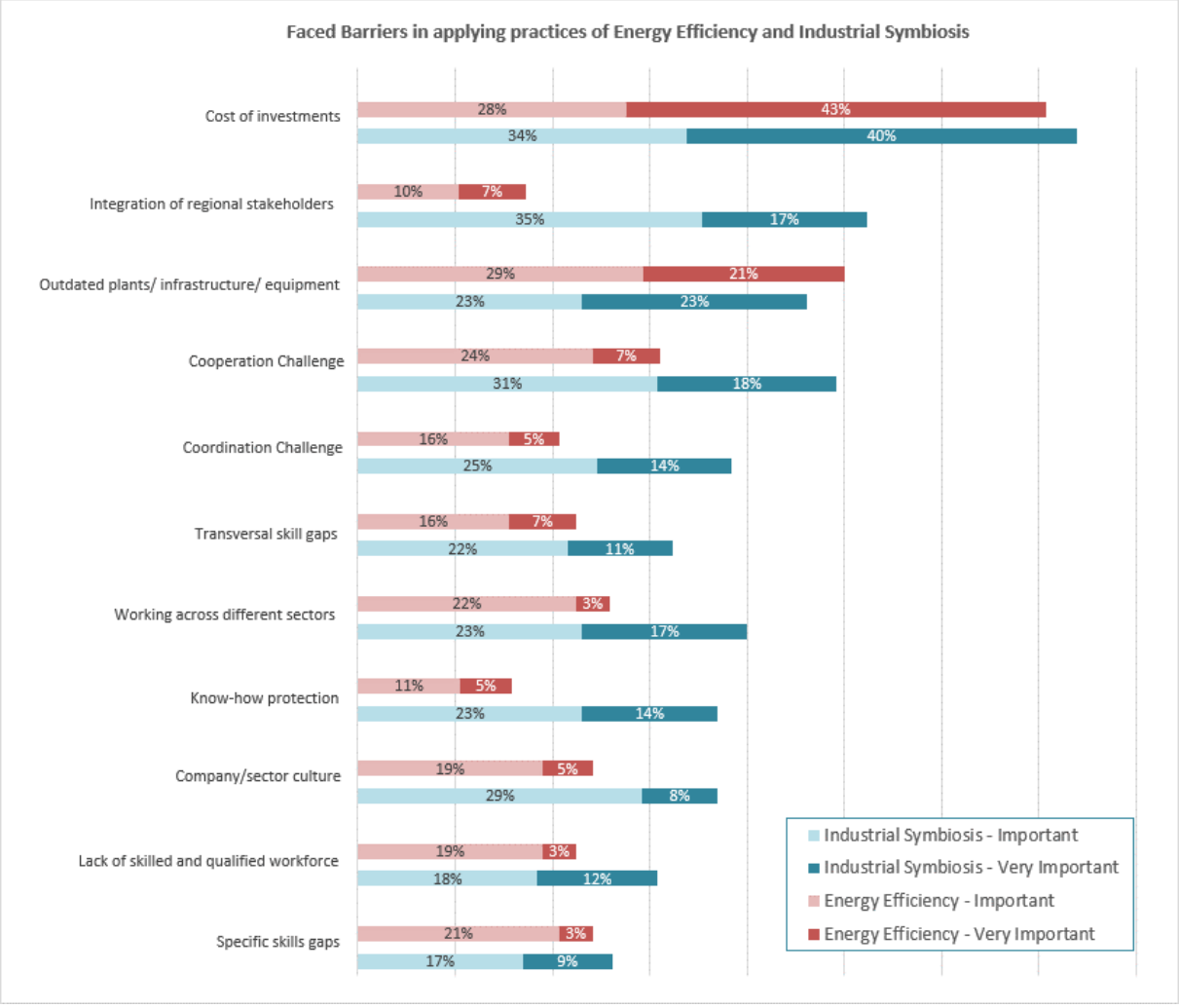
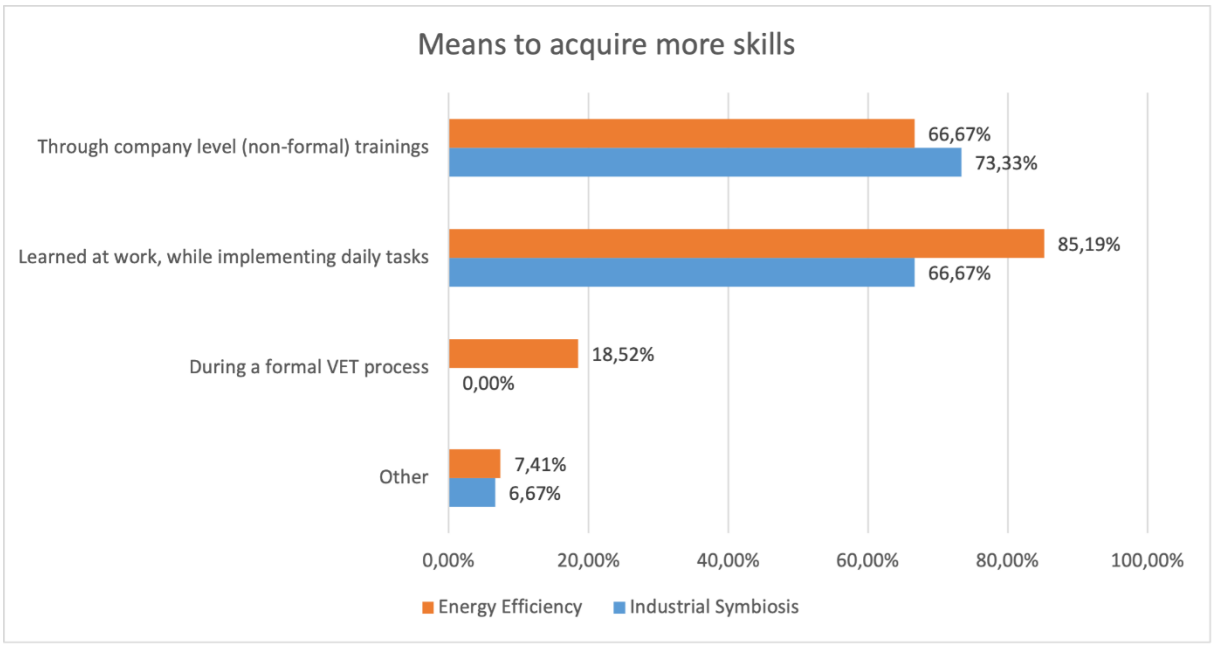


Figure 6: Importance of Barriers Faced for the Implementation of IS and EE (see detailed figures in the Annex 7.5)

As skills gaps are for about one third of the respondents an (very) important barrier, 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 7). 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 mostly needed to be updated in the incoming 3-5 years are identified in specific job-related skills, digital and personal skills. Other useful skills identified within the survey are regulatory and entrepreneurship skills. Especially low and middle level skills need to be updated.



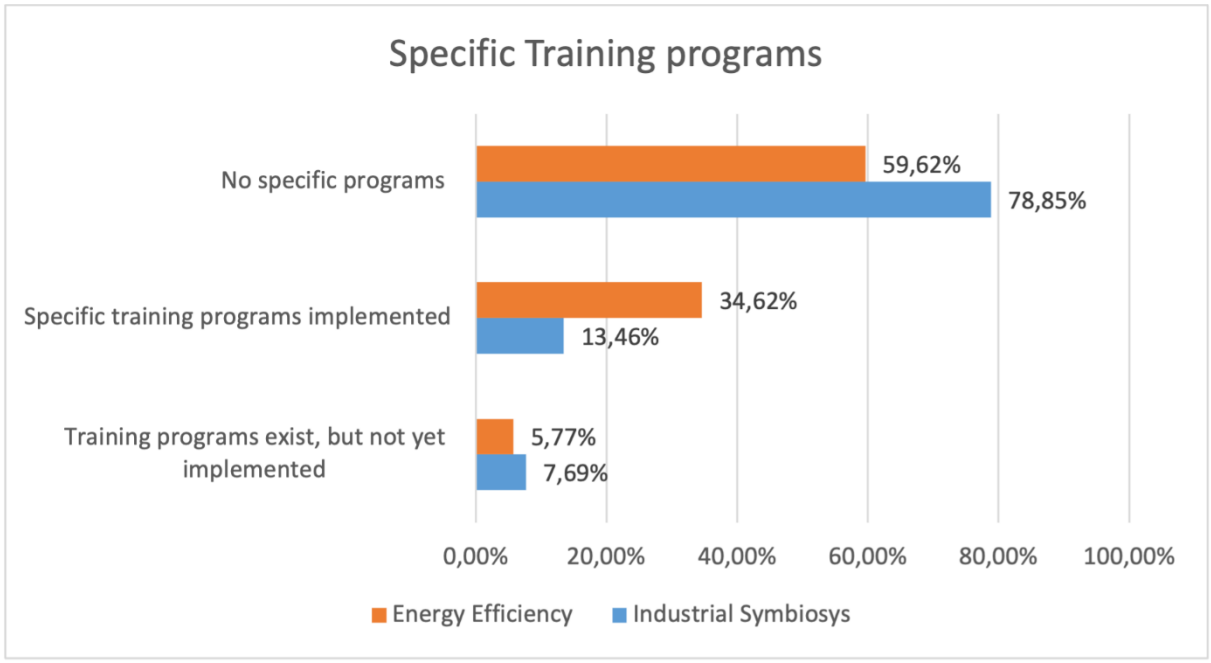


Figure 7: Skill Improvement Strategies

To sum up the results of the technological, economic and related skills review the Blueprint Prototype should focus:

- 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)
- Mainly on an incremental and complementary *upskilling of existing occupations and job profiles* (see Figure 8), but taking also into account *additional new job profiles* (such as the IS Facilitator)
- Differentiating between skills for Energy Efficiency (lower level demand) and for Industrial Symbiosis (higher demand)
- Managerial (business and regulatory) and operational skills (technical, transversal/individual).

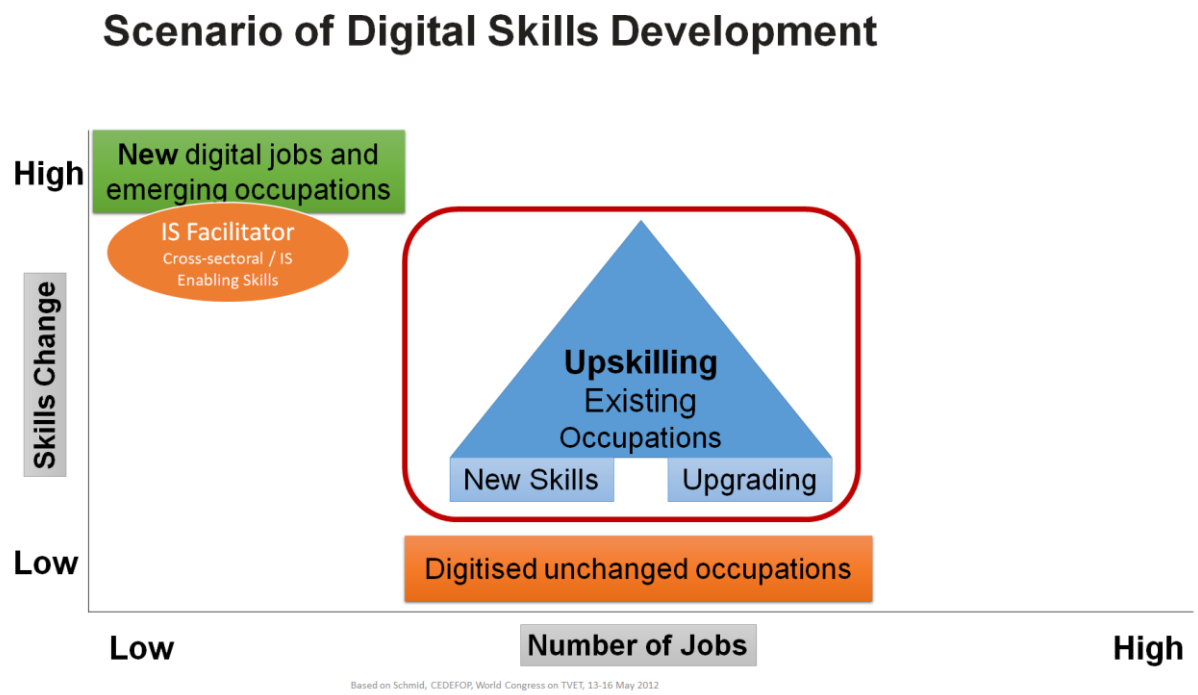


Figure 8: Complementing and Upskilling Existing Occupations are in Focus of SPIRE-SAIS

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, see following chapter). 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

Considering the future technological developments for 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 (European Commission, 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; Sidenor, 2021), new skills and training needs within the SPIRE sectors were explored. Focusing on near future changes in the professional skills requirements of the SPIRE industries, the framework of increasing environmental constraints and energy costs as well as a possible incorporation into VET and tertiary education training curricula have to be 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 7.4)

3. Creation of organisational flow charts in different sectors selecting job profiles related to Industrial Symbiosis (see Annex 7.6)
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. Development of a job profile related skills assessment template.

Steps to be foreseen are:

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

As the literature review summarised in Deliverable D3.2 (Sidenor, 2021) and the Fact and Figures (added in Annex 7.4) are the ground for the industry requirements analysis, the following will focus on the main elements for the Blueprint Prototype development: organisational flow charts of the sectors leading to the job profile identification and selection, and the related skills classification.

2.2.1 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 9 below is illustrating the step by step procedure applied in the ceramic sector as an example.

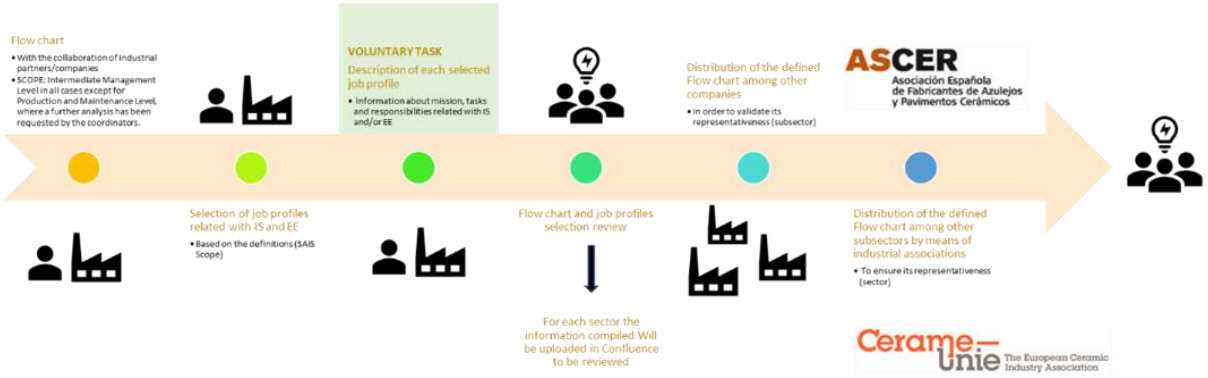
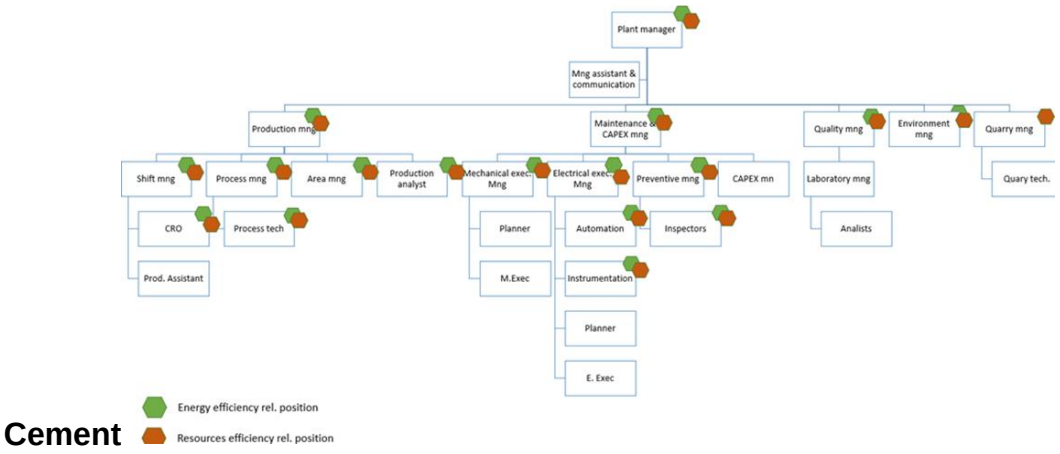


Figure 9: Development Process of sectoral Organisational Flow Charts and Job Profile Selection

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 7.6). 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. Another differentiation is the one 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.



Cement

Steel

Figure 10: Organisational Flowcharts (Example Steel and Cement)

Based on this process done by the companies involved in SPIRE-SAIS, we got a huge list of job profiles in the different sectors. To reduce complexity, they were grouped in sector overarching main job profiles to be accepted as a common basis for identifying related skills.

2.2.2 Job Profile Identification and Selection

Based on a literature review, facts and figures datasheets, organisational flow charts and job profile and skills selection of the different sectors was done by the involved companies and reflected by the consortium, esp. with the sector associations. As it was not so easy to find a common overarching organisational flow chart description in each sector (because every company has its own specifications and production areas, products) agreeing on an overarching selection of similar job profiles across all sector was challenging as well. Reflecting the results of the technological development, concentrating on the highest common denominator and reducing complexity to a manageable list, first sector overarching job profiles affected by indus-

trial symbiosis and energy efficiency were selected (see also Figure 10). Therefore, the Blueprint Prototype 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)
- added by a new cross-company Industrial Symbiosis Facilitator enabling function and job profile.

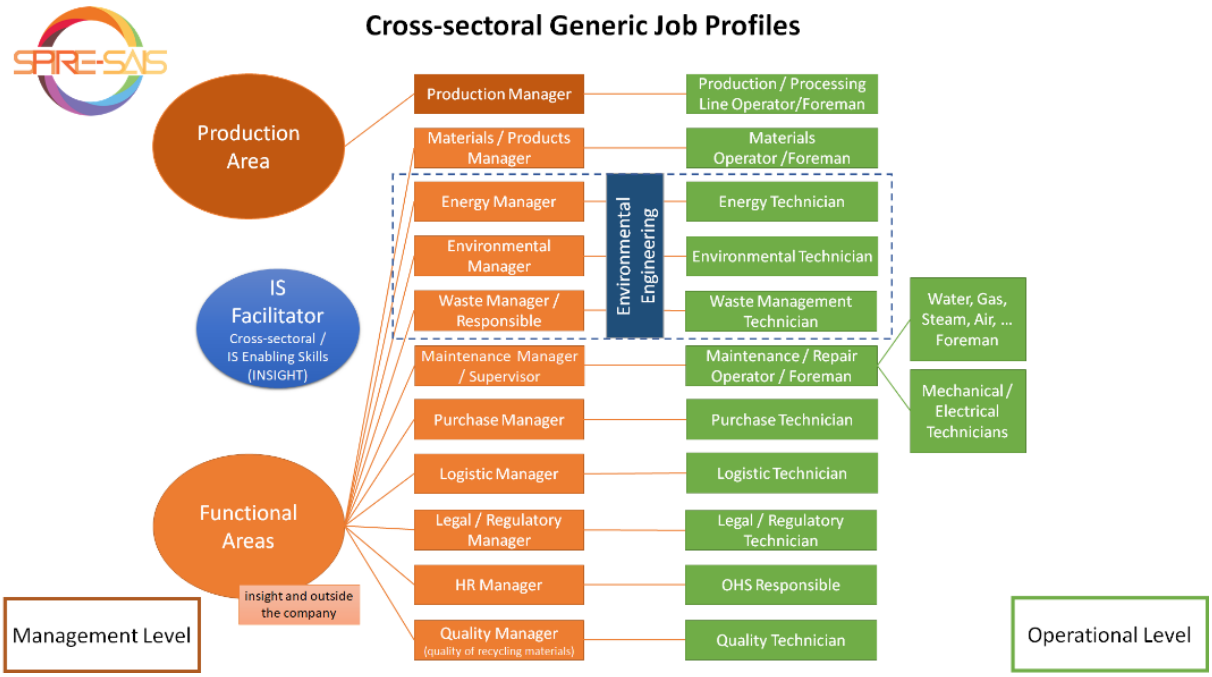


Figure 11: Cross-sectoral Generic Job Profiles and Functions for EE and IS

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 will be checked, esp. 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.

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 profiles: 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 under development by the INSIGHT project, SPIRE-SAIS is looking for an integration and a continuous running of this profile and related training offers in the planned Skills Alliance and Training Platform during the course

and beyond of the project life span. Looking at the curriculum of the training course for the IS Facilitator (see Figure 12), management and transversal skills similar to the SAIS ones could be identified, but focusing evidently on the cross-company cooperation perspective which could be perfectly combined with the company and cross-sector related SPIRE-SAIS approach. The IS Facilitator therefore could be 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 12: IS Facilitator Curriculum (INSIGHT 2020, p. 8)

2.2.3 Skills Classifications

In parallel and attuned with the selected job profiles, a first selection 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. Those skills were rated by their importance and reduced to at least a manageable bundle of skills topics/families/groups (see Figure 13). 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 skills categories do have several related skills classifications differentiated only in the technical/technological category in 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 the following Figure.

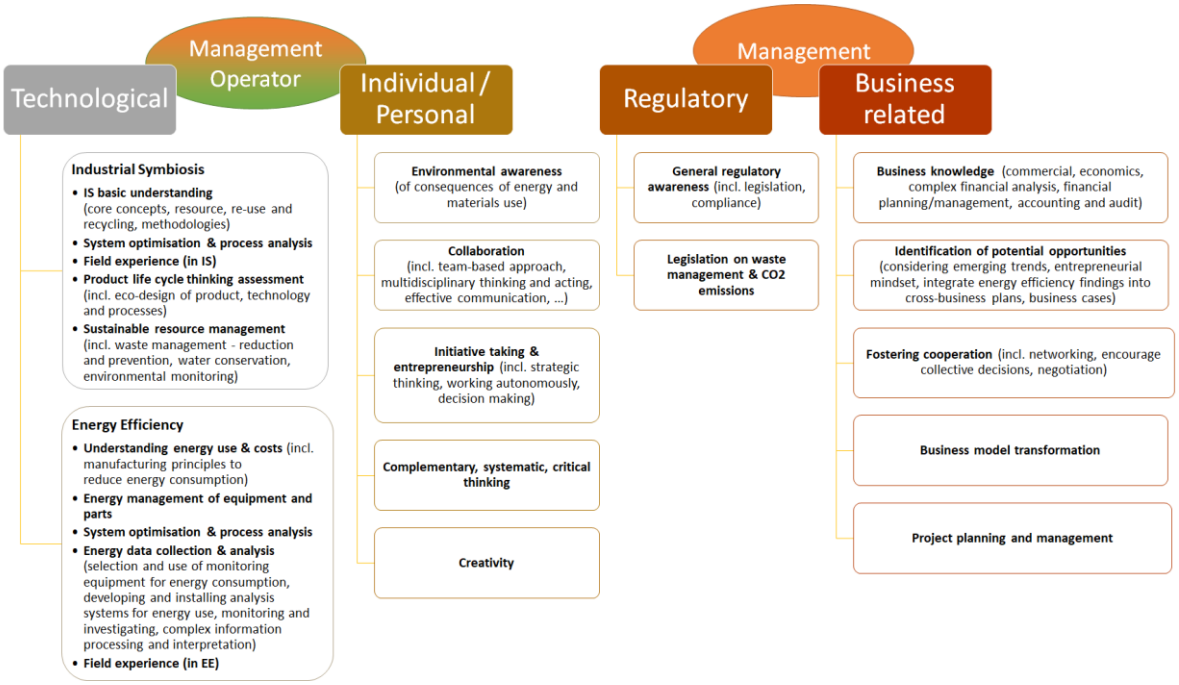


Figure 13: Skills and Competences Selection

Further steps are the definition of concrete skills and competences and proving the role of digital technologies and skills as a means and precondition for improving sustainability. This will be done in line with existing skills, competence, and occupation frameworks (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).

2.2.4 Skills Assessment

Harmonising the job profiles of the different industry sectors into one common template in order to reduce complexity and achieve an effective match of occupations and skills profiles, SAIS is aiming at generating a common ground combining the industry and VET (system) perspective. Our European job profile related skills assessment may also be used to implement an

effective skills and competence assessment process in the companies. Defining and implementing an internal competence assessment process enables verification of an organisation's existing roles and aids identification of skills gaps. The result of the assessment can be used to improve accuracy of different processes:

- In training, the skills and competence gap analysis can be used to design accurate training paths that can, for example, develop the proficiency levels required to meet organisation requirements.
- In the development of an organization, the result of the assessment can be used to guide the design of the organization itself, allocating resources optimally and identifying skills and competence shortcomings to inform the recruitment process.
- In career development, recruitment and talent management, the outcome of individual assessments can be used to identify optimal career development paths, benefiting the employee and the organisation.

To make an assessment process accurate and effective, a **skills checklist** is under development focusing on the specific job profiles and their related skills. This checklist is following the T-shape approach combining specific specialised skills with transversal skills as well as business and regulatory skills. The approach was taken because beside essential and optional production related technical skills, industrial symbiosis and energy efficiency ask especially for an improvement of personal/individual soft skills and business and cooperation skills.

The skills assessment will be done by a template or checklist leading to a dedicated job profile assessment and description of the mission, the main tasks and related skills for these tasks. It will be combined if possible with the related ESCO/ISCO occupation and equivalent profiles. The skills will be assessed by five proficiency levels ranging from 0 Novice to 4 Master:

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

The template evolved towards the industrial needs incorporating sections for job description, mission, tasks etc. (from ESCO) and creating new sections for new skills categories, equivalent job profiles and skills levels. Three examples illustrate job profiles related skills assessment for a manager, operator, and technician comprising beside the hierarchy level also EE and/or IS and different sectors:

- Energy Manager (EE and IS) (see Annex 7.5c)

- Waste management technician (Liquid Waste Treatment Operator) (see Annex 7.5d)
- Maintenance and Repair Operator (refractory bricklayer) (see Figure 14)

PROFILE TITLE	Maintenance & Repair Operator (Refractory Bricklayer)		
ISCO Code	7112.1		
Mission	Bricklayers assemble brick walls and structures by skilfully laying the bricks in an established pattern, using a binding agent like cement to bond the bricks together. They then fill the joints with mortar or other suitable materials.		
TASKS	Current	Future	
Main task/s	Lay bricks, pre-cut stones and other types of building blocks in mortar to construct and repair walls, partitions, arches and other structures such as smokestacks, furnaces, converters, kilns and ovens, piers and abutments;	(here it should be listed, which tasks are changing/modified in which way, and if new tasks appear)	
Equivalent profiles	Refractory masonry officer Refractory Technician Refractory linings technician Refractory lining coordinator Refractory lining Supervisor Refractory lining foreman Refractory Preparation Operator Refractory Supervisor		
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		

Figure 14: Skills Assessment of Selected Job Profiles (Example Maintenance and Repair Operator)

All the development and tools described above influence the development of the final Skills Assessment Tool for analysing the different skills dimensions, topics, proficiency levels in relation to the importance and priorities of the companies. Based on this valuation the current

skills level and Industrial Symbiosis Readiness Level of a company will be calculated (see Figure below as a first attempt).

DIMENSION	SKILLS	TOPICS	CURRENT STATE/LEVEL OF PROFICIENCY/READINESS LEVEL	IMPORTANCE FOR THE USER/COMPANY Indicate the importance !!! !! !	Priority to achieve the skills
TECHNOLOGICAL (IS)	IS basic understanding	Do you know what industrial symbiosis is?	Intermediate knowledge	!!	Priority 2
		Do you know how IS is related to sustainable development?	Low knowledge	!	Priority 2
		Do you know how IS is related to circular economy?	Advance knowledge	!!	Priority 3
		Do you know the role of the business in IS?	None	!!!	Priority 1
		Do you know the type of resources likely to be part of an industrial symbiosis?	Advance knowledge	!!!	Priority 3
	IS core concepts	Do you know the different types of IS?	Low knowledge	!!	Priority 1
	Other skills...	etc.			Indicator or importance not scored
BUSINESS RELATED	Financial management	Do you know the implications of SI for financial management?	None	!!!	Priority 1
		Do you know the financial challenges and possible solutions?	Low knowledge	!!!	Priority 1
	Identification of potential opportunities	Do you know the main benefits arising from applying IS principles?	Low knowledge	!!	Priority 1
	Financial tools	Do you know financial tools related to IS?	None	!!!	Priority 1
	Business models	Do you know the different business models related to IS?	None	!	Priority 1
		Do you know Symbiotic Business Strategies and their relation to the resource flow?	Intermediate knowledge	!	Priority 1
	Other skills...	Etc.			Indicator or importance not scored

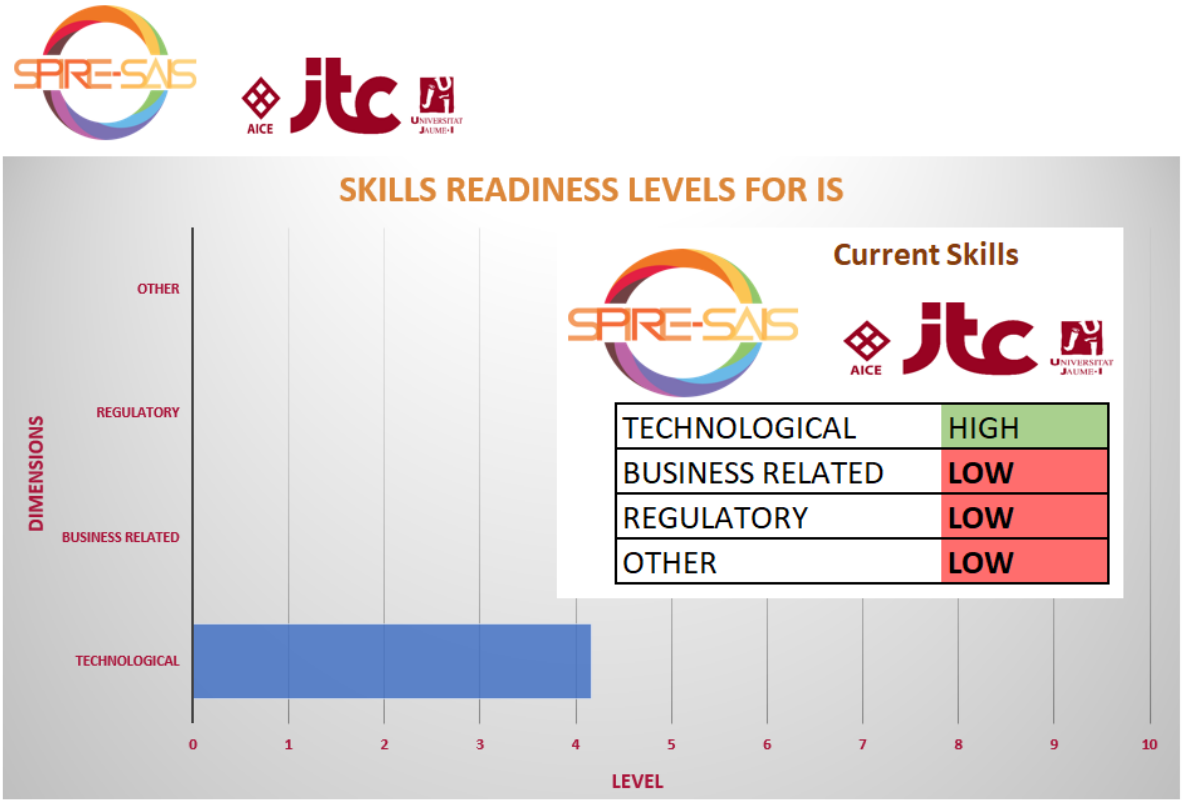


Figure 15: Skills Evaluation Template

2.2.5 Alignment of SAIS Job Profiles and Skills with European Tools and Education Systems

To avoid a standalone solution, the selected job profiles and skills categories for Energy Efficiency and Industrial Symbiosis will be aligned as much as possible with relevant European tools. This will be done to 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 will integrate the ESCO/ISCO description within our Job Profile Description and Skills Assessment Template (see ISCO/ESCO code in the Figure above) and align the SAIS Job Profiles with the equivalent ESCO occupation (see Figure 16). 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

Figure 16: 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 em-

ployment - 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 education and training: for the development of training courses, tools and activities but also for talent management and recruitment purposes.

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 the Figure below). 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 will be 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.).

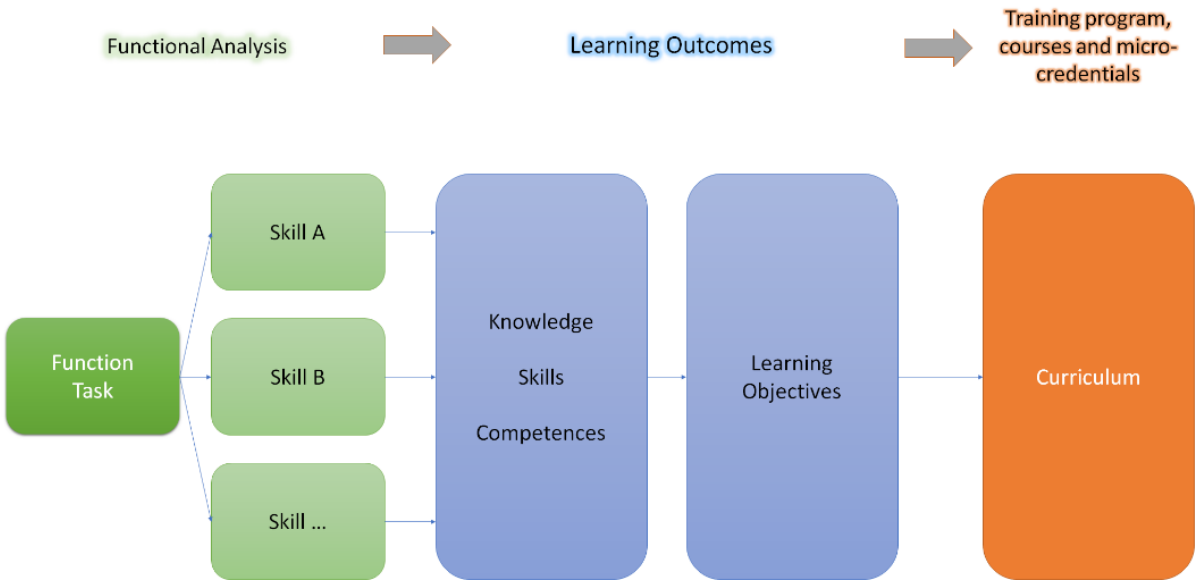


Figure 17: From Functional and Skills Analysis to Learning Outcomes

2.3 VET System Support

The VET system review for skills demands on Industrial Symbiosis and Energy Efficiency is reflecting VET systems in five countries, representing different VET structures: Germany, Italy, Poland, Portugal, and Spain. Via this analysis good case studies are gathered in a repository (see recent status in the Annex of Deliverable D5.1; Almeida et al., 2021). A selection of them is illustrating the provision of skills relevant for IS and EE in this chapter. Additionally, an initial idea and structure of a skills' matrix database with components and functions, incl. an example for one job profile (Refractory Bricklayer), was created.

2.3.1 Key Features of VET Systems

Comparing the five analysed VET systems by some key elements for an integration of SPIRE-SAIS industry skills requirements (as summarised in Table 1), several commonalities and differences in the design and recent general reforms of the analysed systems emerge being relevant for connecting SPIRE-SAIS solutions:

- **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[1]. This does not allow for a swift adaptation of the teaching content to quickly evolving 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).

[1] 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).

Table 1: Overview of Selected VET Systems

	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)

Further important elements discovered are the strategic planning and implementation of IS- and EE-related green skills in national policies and VET activities.

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

Except for Germany's 'National Action Plan for Sustainable Development in Education' (Bundesministerium für Bildung und Forschung, 2017), no specific strategies for green skills delivery have been identified in the target countries. Broader national educational strategies rarely explicitly mention green skills[2], 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 education for sustainable education, focused on giving information and shaping behaviour and detached from skills training.

[2] For instance, in Poland, a term “skill of the future” is used.

Table 2: Good Practices of IS- and EE-related Skills Provision: Policy Level

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.
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.

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

National context

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

- The proliferation of sustainability-focused programmes varies across 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 visibly lags with 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 delivery 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).

- Across virtually all countries, the importance of extracurricular activities, often provided by organisations outside the VET systems, has been stressed. Therefore, the delivery of green skills is more likely to be non- or informal and provided on ad-hoc basis.

Table 3: Good Practices of IS- and EE-related Skills Provision: Implementation Level

'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.

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 is in this area is important – firstly, many successful initiatives are delivered internationally or with the support of international stakeholders[3]. Secondly, a share of nationally or regionally organised green skills training initiatives depends on international (EU) funding. In Italy, for example, the European Social Fund is a primary funding source for upper-secondary VET and CVET.

[3] 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.

Table 4: Good Practices of IS- and EE-related Skills Provision: International Dimension

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.
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.

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

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

- **Educators' readiness:** Teachers often lack competencies and knowledge on how to teach green skills effectively.
- **Poor evidence base:** Robust assessments of relevant educational programmes' effectiveness are necessary to replicate the good practices.
- **Course structure and tools:** Establishing a cross-sectoral IS/EE module that could be integrated in 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 upon completion of training) and hinders skills tracking and forecasting.

Other important barriers include:

- **Lack of coherent 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 not guided by a single overarching strategy.
- **Insufficient funding:** Funding tends to be fragmented and short-term.

2.3.5 Idea of the Skills Matrix

To get a better overview of the approaches of the different VET systems related to the job profiles and skills demands identified in SPIRE-SAIS we started to elaborate a matrix of cross-sectoral IS and EE skills. This matrix is comprising the following three key interrelated functions:

- **to "connect" different concepts used in the SPIRE-SAIS project including job profiles, occupations, and qualifications**
- **to identify how IS and EE related skills needs are addressed in relevant VET programmes:** Information about jobs and IS and EE skills' needs is identified by the foresight survey and the industry requirements. At the same time, relevant VET programmes are analysed to find out if and how these specific skills are addressed.

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 will identify relevant national qualifications that exist in different countries. Therefore, representatives of the industry will know whether 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.

European Level

Job and skills				Description of the job in EU frameworks							
Job profile (WP3 input)	Alternative job profile titles	Skill Needs (identified by the industry)	Aimed skill level (identified by the industry)	ESCO group occupation label	ESCO/ISCO group code	ESCO occupation label	ESCO/ISCO occupation code	ESCO Alternative labels	ESCO Skills relevant for IS	ESCO Skill alternative label	ESCO Skill reusability level
efractory ricklayer	Refractory masonry officer Refractory Technician Refractory linings technician Refractory lining coordinator Refractory lining Supervisor Refractory lining foreman Refractory Preparation Operator Refractory Supervisor	Environmental awareness	2	Bricklayers and related workers	7112	Bricklayer	7112.1	industrial oven brickmason trowel occupation worker brick laying labourer specialist brick layer brick laying worker brick layer	Sort waste	categorise waste sort refuse organise waste separate waste into different categories perform activities to separate waste sort rubbish conduct activities to separate waste sort garbage organise refuse perform waste separation activities arrange waste group waste according to characteristics	cross-sector skills and competences
		Energy efficiency	2								
		Water conservation	3								
		Waste reduction and waste management	3								
		Resource reuse/recycling	3								
		?Procurement	?2								

National Level: Germany

JOB & QUALIFICATION (in DE)			German National Frameworks				Integration of EU Framework				IS and EE Skills Readiness							
ESCO group label (in DE)	(Alternative) Job Labels (in DE)	Qualification label (in DE) (Berufsausbildung)	KldB 2010	DQR (GQF)	Programmes providing this qualification	Duration in	Certificate in Europass Format	ISCED Info	EQF	ESCO	Skill needs	Needed skill level	Whether this skill is sufficiently addressed in the DESCRIPTION OF QUALIFICATION? (YES/NO/partly)	How this skill is integrated in the DESCRIPTION OF QUALIFICATION?	Whether this skill is sufficiently addressed in the particular QUALIFICATION PROGRAMME? (YES/NO/partly)	How this skill is integrated in the particular QUALIFICATION PROGRAMME?	Whether this skill is sufficiently addressed in the particular QUALIFICATION PROGRAMME? (YES/NO/partly)	How this skill is integrated in the particular QUALIFICATION PROGRAMME?
															Name of the programme: Hochbaufacharbeiter/-in im Schwerpunkt		Name of the programme: Maurer/-in (1. und 2. Stufe)	
Maurer/ Maurerin	Maurerin Maurer	Maurer/Maurerin	32122	4	Hochbaufacharbeiter/-in im Schwerpunkt Maurerarbeiten (1. Stufe)	2 years	https://www.bibb.de/dienstleistungen/de/berufesuche_phpIconfiguration_supplement/maurer_e.pdf	3B	4	Yes	Environmental awareness	2	No	Not mentioned	Partly	Recommended outcome to achieve the learning outcome: "Sorting, transportation and management of household and construction waste"	Partly	Recommended outcome to achieve the learning outcome: "Sorting, transportation and management of household and construction waste"
					Maurer/-in (1. und 2. Stufe)	2,5 years					Energy efficiency	2	No	Not mentioned	No	Not mentioned	No	Not mentioned
											Water conservation	3	No	Not mentioned	No	Not mentioned	No	Not mentioned
											Waste reduction and waste management	3	No	Not mentioned	Partly	Recommended outcome to achieve the learning outcome: "Sorting, transportation and management of household and	Partly	Recommended outcome to achieve the learning outcome: "Sorting, transportation and management of household and construction waste"
											Resource reuse/recycling	3	No	Not mentioned	No	Not mentioned	No	Not mentioned
											?Procurement	3	No	Not mentioned	No	Not mentioned	No	Not mentioned

Figure 18: Database of Occupations across the Pilot Countries (Matrix Example EU – Germany)

3 The Supply Side: Strategies and Measures

The SPIRE-SAIS Blueprint is answering the industry skills demands with the establishment of a **Skills Intelligence Hub** with a **Foresight Observatory.** An **Online Training Platform** and a related **European Training Community for Industrial Symbiosis** is under construction, supported by **Image and Recruitment** concepts.

3.1 Skills Intelligence Hub and 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 as well. Therefore, we will establish a **Skills Intelligence Hub for Industrial Symbiosis (SIHub)** and a **European IS Training Community** as the core coordination elements of SPIRE-SAIS. Within the SIHub:

- Technology and skills foresight will be done within a **Foresight Observatory** 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 and run by the SIHub.
- Recommendations, self-assessment tools, 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.
- An **Online Training Platform** will be established giving immediate answers to the industry skills demands (see in detail section 3.2.2).
- 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 will be defined in an Open Coordination way, dividing responsibilities between the main and willing actors.

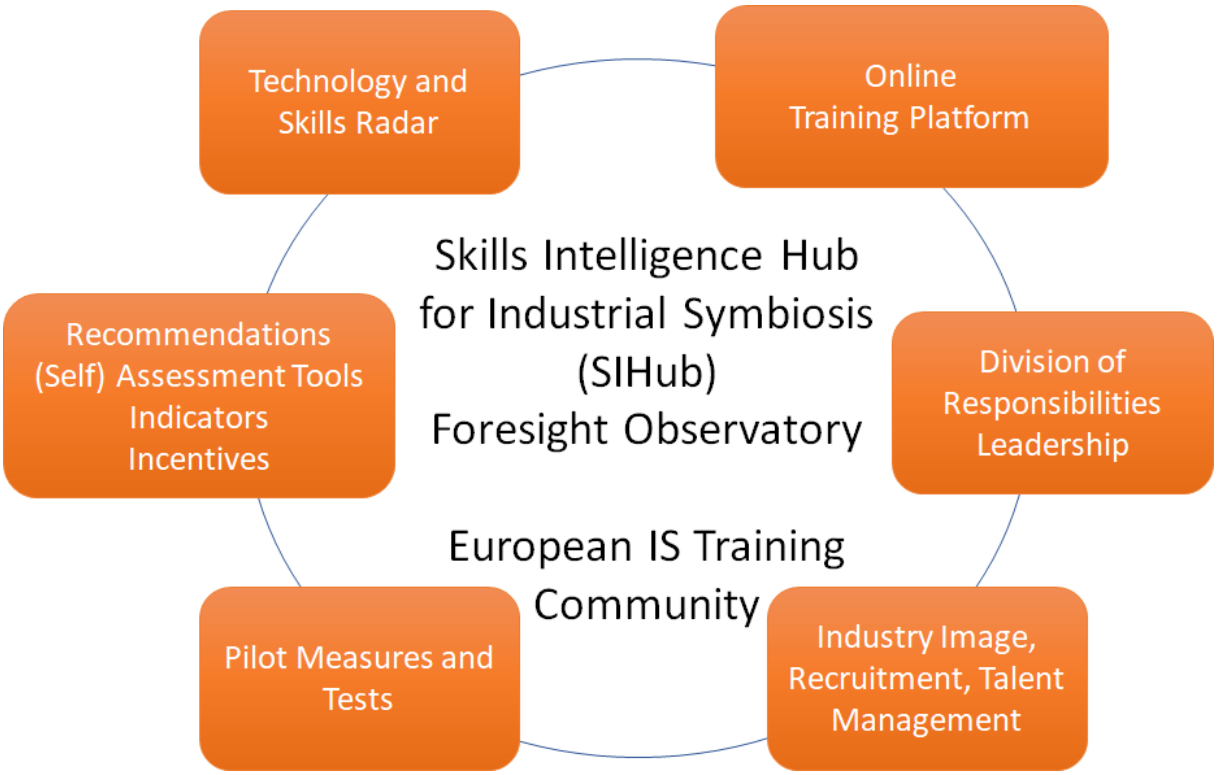


Figure 19: Skills Intelligence Hub and Training Community

The *Skills Intelligence Hub (SIHub)* will be the core element of the coordination of SPIRE-SAIS, including a *Foresight Observatory* with a regular survey giving insight in the recent and coming technological and economic developments concerning Industrial Symbiosis and related Energy Efficiency skills demands. This *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 SIHub will integrate a **Project Repository,** initially designed for collecting material from partners to develop the desk research for the technological and economic development and skills demands. However, this repository might be a good reference disseminated to the whole 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 the SPIRE. In addition, a cross-sectoral project section is present, including projects on Industrial Symbiosis and Energy Efficiency that are transversal across the different involved sectors. The template for collecting the projects comprises different aspects listed in the figure below: Sectors involved, funding scheme (e.g. RFCS, FP6, 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). During the course of the SPIRE-SAIS project the repository will be updated continuously taken over by the established SIHub 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 20: Project Repository (Template)

3.2 European Industrial Symbiosis Training Community (Training Framework)

The SPIRE-SAIS Training Framework in its first version December 2021 (see in detail D5.1; Almedia et al., 2021) outlines the structure of the foreseen online training measures foreseen to close the identified skills gaps of the identified job profiles for Industrial Symbiosis and related Energy Efficiency. After a first discussion of possible upskilling schemes, mechanisms for implementing tailor-made and demand-oriented trainings were created.

3.2.1 Upskilling schemes

A workshop with companies and training providers about training measures and upskilling schemes compared the experiences of centralised sector specific training systems like 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 one stop and open system space centralising and systematising existing training offers and integrating new ones, on a sustainable platform with a business model addressing specific sector 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.

- The discussed **specific target group oriented systems** are developing 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. But they have a project character leading to static and not updated results and no sustainability after the project life span, because a provider and further resources are needed
- **IS 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 of integrating 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, a *challenge* is to find a solution that enables the SPIRE-SAIS solution maintaining itself alive beyond the end of the project. This includes not only a sustainable running of SPIRE-SAIS but also its rollout of training courses to the member states within the different, at least of the main languages. However, the first point to develop from all this is the need to define the nature of the training scheme to be developed. We have to confirm the target audience, which specific companies will be the most interested, which training format will be the most appropriate, as well as which will be the most appropriate exploitation scheme.

3.2.2 Online Training Platform: Industrial Symbiosis Skills Intelligence (ISSI)

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) is foreseen: Centralising and systematising existing training offers and integrating new ones, on a sustainable

platform addressing specific sector 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.

Discussion up to now is going in the direction of a SAIS Online Training Platform: Industrial Symbiosis Skills Intelligence (ISSI). Possibilities of integrating such a platform will be discussed, e.g. in the European Community of Practice for Urban Industrial Symbiosis (ECoP U-IS) (call of HEU to be decided beginning of next year).

To establish such a training platform, **mechanisms** were created for:

- The identification of skills demands, related to industrial symbiosis and energy efficiency, considering skills gaps and needs for IS and EE deployment
- The identification and organisation of (cross)sectoral upskilling and/or reskilling schemes, promoting an efficient knowledge management and skills provision
- The facilitation of instruments and resources that allow the implementation of measures to meet the identified skills needs.

The identification of skills demands will be based on the already described job profiles (see Figure 11) and related skills classification (see Figure 13). Against this backdrop of an initial list of skills, 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 (to be published in January 2022) could help 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 in the database 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 21).

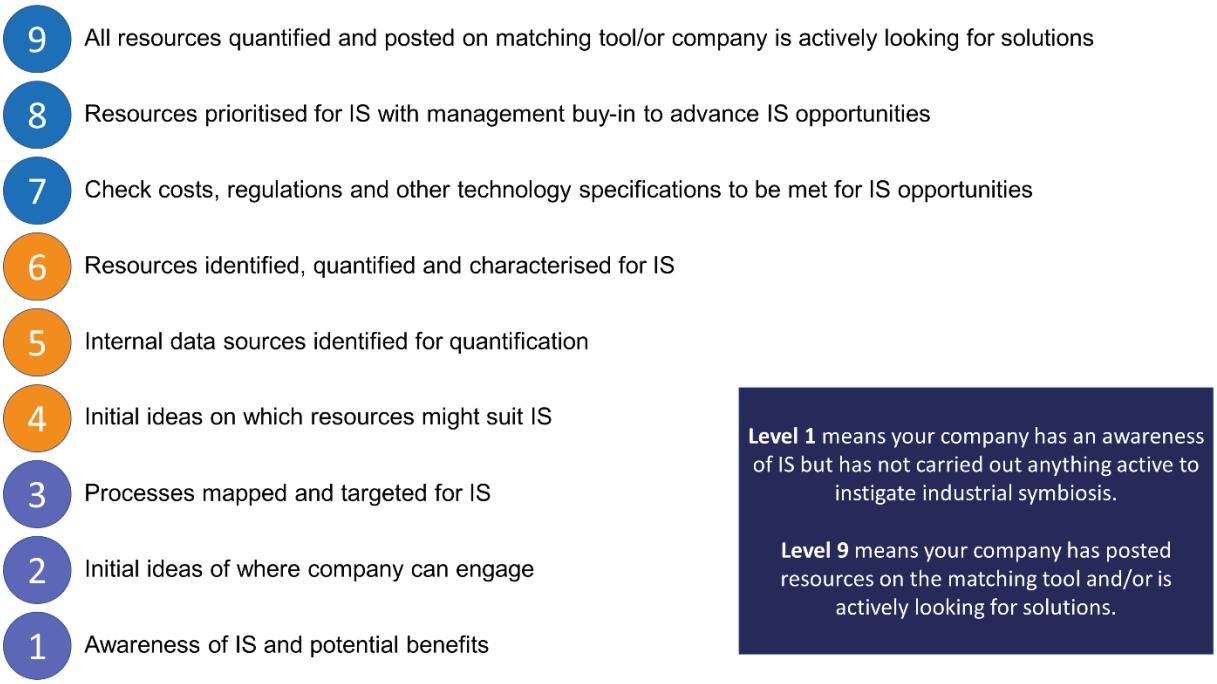


Figure 21: IS Readiness Levels (Adapted by the CircLean project from Sommer 2020)

Based on the analysis of the training needs and already existing educational resources and training courses for IS/EE (see repository in Deliverable D5.1 (Almedia et al., 2021) in the Annex) a 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. These trainings are potentially collated in a database consisting of (a) existing courses to be collected and distributed, and (b) additional courses development if relevant, not existing and capable of being developed by consortium members.

Table 5: Training Database

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

Based on or integrated in a 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

will improve the skills and qualifications in line with specific needs and interests of the learners (see Figure below).

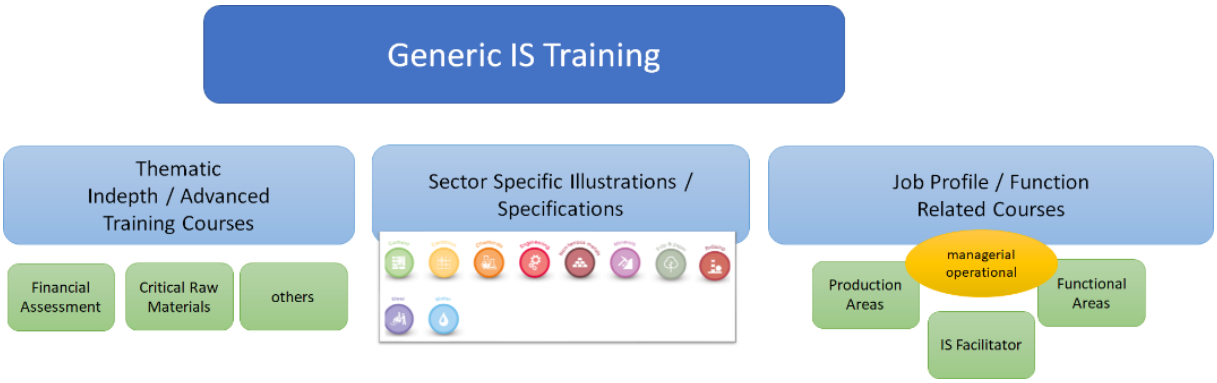


Figure 22: IS Readiness Levels
(Adapted by the CircLean project from Sommer (2020), study and portfolio review of the projects on industrial symbiosis in DG Research and Innovation: Findings and recommendations industrial symbiosis. European Commission)

A connection of the online database to European tools (esp. the European Skills Competence Occupation ESCO Databases) is planned as well as to the formal national VET systems qualification offers to:

- Inform and enable national VET systems authorities to communicate new qualifications of Process Industry (in general) and IS (in particular). This will provide a wider visibility to national VET systems' efforts towards contributing to a more sustainable society.
- Offer the possibility to pinpoint existing qualifications offer 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 address language.

Important part of the (online) Training Framework will be also **Train the Trainer** approaches, guidelines and existing programs, integrated in the SIHub with close connection to the industry needs and the education systems (i.e. the relationship between trainers/educators and training/education). This will address:

- Strategies and guidelines in order to get the trainers (internal or external, but especially external education system ones) closer to workers, and therefore reach a greater assimilation of the taught lessons.
- Didactical measures to foster lifelong learning, active learning, work-based learning, combining digital with on the job learning.
- Managers to become "trainers" of their subordinates (new leadership), getting suitable skills for "teaching" on the job.

Regarding the 'train the trainers' approach, active learning methodologies have been proven as more efficient than the traditional methods. These learner-centred methodologies provide learning based on tasks, problems, projects, challenges, case studies, etc. engaging and motivating the involved learners and workers. Goals are the construction of workplace-oriented learning, the provision of an active process of knowledge construction, keeping the learners'

attention, emphasizing their independence and inquiry, and, in the last term, improving the pass rates. For instance, problem and project-based learning enhance “self-directed learning” skills, changing the usual trainer/teacher role towards a mentoring and coaching role. Using scenarios and authentic tasks and settings of the workplace, or solving real cases and actual problems of the companies, will also improve the trainer’s/teacher’s capability of reflecting practical demands for their training.

Because of the fast-changing technologies and the more incremental upskilling, new leadership (Kopp et al., 2021) of the identified managers of the different production and functional company areas (see figure 11) should consider them as "trainers" of their subordinated operators, foremen, and technicians. Therefore, they have to get suitable skills for "teaching" on the job and in the workplace. The challenge for trainers and managers is to combine the implementation of new technologies and strategies with the necessities and demands of the specific workplaces (workplace innovation). The challenge for SPIRE-SAIS is to address the teachers and trainers of the different national education systems with a more on the job training and education (e.g. via their movement to dual study in VET and Higher Education).

New training methods and arrangements, taking into account new possibilities of digital learning and support (such as social media, Moodle, virtual labs, online learning, gamification, mobile apps, virtual reality) and workers participation (e.g. workplace innovation, and by using digital tools like tablets, smart phones, laptops, etc.) should be in place, not only for the design of training courses but even for improving digital skills of the trainers and the (training) managers.

3.3 Image – Recruitment – Talent Management

Beside training measures and not at least, image, recruiting and talent management are key for the green and digital transformation of the energy intensive industries. SPIRE-SAIS is taking care of this by integrating this aspect in the development of the Blueprint strategy to overcome central human resources challenges of the energy intensive industries by:

- **Improving the attractiveness** of the Intensive Industries and fostering **careers for talented people** (recruitment and retention),
- Including the identification of strategies for overcoming recruitment difficulties and widening the talent pool for a more **diverse workforce** (with knowledge of cross-sectorial needs and opportunities for cooperation)
- **Increasing the workforce mobility and diversity** (e.g. increasing the attractiveness of Intensive Industries for women).

Within a workshop with the involved companies and a validation by the General Assembly of SPIRE-SAIS, 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.

Main challenges

The *negative image* is known for a long time, leading to a lack of interest to work in energy intensive industries on the site of students. There are concerns about security, health and safety, also connected to a critical public view, e.g. on the steel sector, which is seen as an old and decreasing economy and as crisis-ridden sector. Another example is the chemical industry, which is struggling with the image of an industry with security issues due to accidents.

Especially with regard to the attraction of female graduates there are recruiting difficulties in the male-dominated energy intensive sectors.

Additional *obstacles* are placed on the individual level: Here, the salary level or unpopular working hours and working models, e.g. night shifts, should be named. Above that, the geographical situation (as companies are often placed in remote areas), a lack of political support for process industries, and an investment and innovation backlog also pose great challenges for energy-intensive industries.

A *lack of suitable applicants* in general and especially in the field of industrial symbiosis also has a critical impact: Specific knowledge on the side of applicants and an overview over different disciplines is missing. This leads to the *need of specific skills for industrial symbiosis:* Thereby, on the one hand, practical experience is required, on the other hand, an understanding of new competences (circular economy/environmental issues) is also important. The companies of each sector have difficulties in finding graduates with such specific knowledge. Furthermore, there is a lack of specific job profiles for industrial symbiosis.

To answer these challenges, companies do their best to master these Human Resources challenge by *in-house training and development and specific public campaigns*. Companies provide such specific training, as knowledge from university is often not sufficient and too general (especially with regard to industrial symbiosis) for the shop floor activities. Consequently, Industrial Symbiosis and Energy Efficiency job profiles are formulated in a holistic way by companies, to attract people with a variety of general and specific skills. Above that, companies foster cross-department work and discussions about different issues of Industrial Symbiosis and Energy Efficiency.

Company campaigns underlining the relevance of energy intensive industries to be recognized in public appear as a promising strategy. Yet, these campaigns have to go hand in hand with an *improvement of relationship and cooperation between energy intensive sectors and universities/VET systems/secondary schools:* More specific courses are needed, especially with regard to industrial symbiosis (see section 2.3, VET system analysis). The image for the energy intensive industries needs to be improved at universities, in the VET system and in secondary schools. Public support is thereby needed to improve the image by underlying the importance of solutions for energy intensive industries with regard to climate change: *Industry as solution provider* and a chance for (new) applicants to make climate change happen.

Some *success factors* are:

- Salary (steel sector salary is higher compared to other sectors)
- Early bond to schools, communicating directly to the pupils
- Stability and the ability to cope with crises
- Field for research in order achieve to climate goals
- More flexibility to combine work and family (e.g. home office).

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

Finding applicants in Energy Efficiency seems to be less of a challenge compared to industrial symbiosis. As already stressed, there is no *specific job profile for industrial symbiosis*. However, people with skills in industrial symbiosis need to be in high positions in order to have the right access and to be close to decision makers, having in-depth knowledge of the company structure. Operation risk managers are needed as well as manager for infrastructure integration. Nevertheless, there has to be a balance between (young) people with fresh ideas and

employees with the right experience, as well as an interplay between manager and operators on a lower skills level. Preferred solution is to *work in industrial symbioses and energy efficiency related teams*.

As *compliance and competition* laws are an obstacle for companies to exchange information (openness, trust) with regard to industrial symbiosis. Therefore, skills and competences are needed on the side of managers and employees in order to understand to what degree companies can exchange ideas and cooperate within such compliance arrangements.

Skills for mastering and managing green (and digital) transformation are consisting of *hard and soft skills*: Technical skills (esp. in STEM) are needed as a basis, but also soft skills, such as motivation, openness, adaptability, and willingness to support change. The *mobility of workers* has to be supported by the availability to travel and of language competence in demand, and also by improving the qualifications of candidates that vary according to national VET systems.

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*. To this end, a new European and national industry strategy is needed (see German Steel Action Concept 2020 "For a strong steel industry in Germany and Europe"; Federal Ministry for Economic Affairs and Energy, 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.

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.

Further Steps:

- Collection and repository of already existing campaigns and tools improving image and recruitment (good practice exchange across the sectors): e.g. online materials like videos: e.g. from Steel Sector Careers, Pittini's 360° online tour , Minerals
- SPIRE-SAIS contribution to these campaigns has to be checked, esp. from a training perspective
- What can be done commonly in the SPIRE community? What has to be done by the sectors?

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 SPIRE with more than 140 members (companies, training providers, research institutes) encompassing and coordinated by A.SPIRE, 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 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 SIHub and the European IS Training Community will be aligned with and support European activities related to European Energy Intensive Industries (see Figure below), namely:

- Sustainable Process Industry through Resource and Energy Efficiency (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 planned 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, policymakers, 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; CEDEFOP Skills Intelligence Platform; European Skills, Competence, and Occupation Database (ESCO)

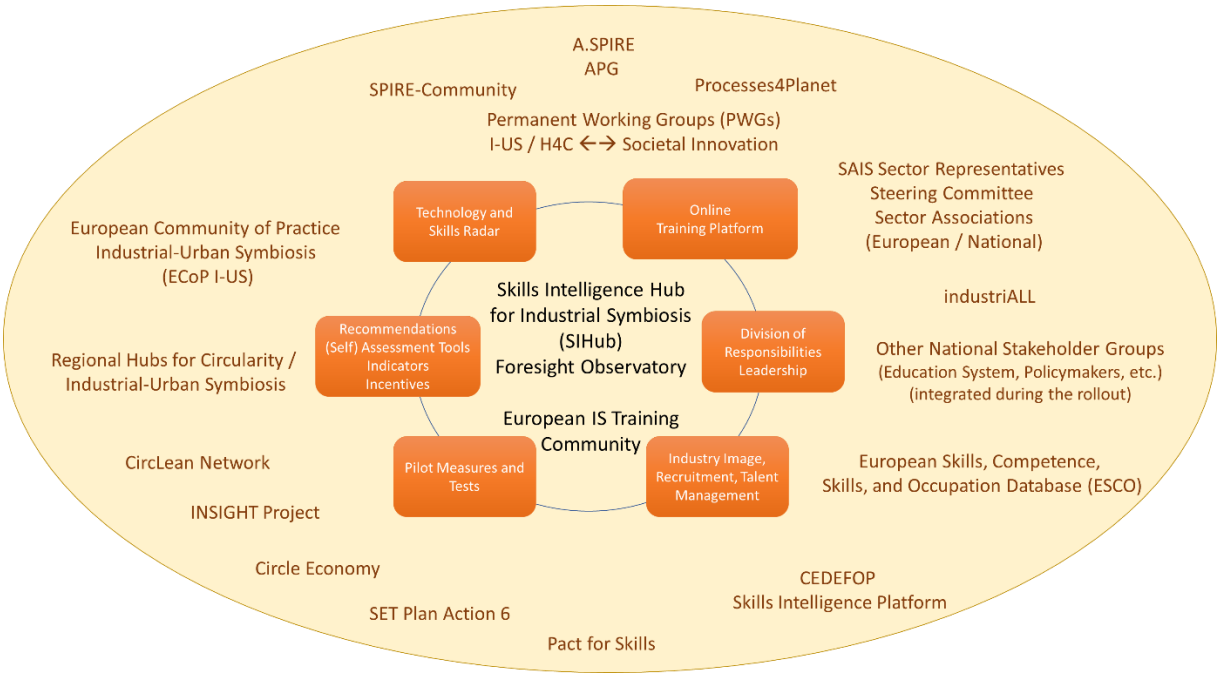


Figure 23: Integration SPIRE-SAIS in European Activities on Energy Efficiency and Industrial Symbiosis

4.1.1 SPIRE / Process for Planet

As being the central coordination element of SPIRE-SAIS, the **Skills Intelligence Hub for Industrial Symbiosis (SIHub)** has to be aligned with the program and governance structure of the SPIRE Processes for Planet program (P4Planet) and its Strategic Research and Innovation Agenda 2050 (SRIA). As SPIRE-SAIS partners are closely integrated in the development of the SPIRE community and the new SPIRE Roadmap 2050 “Processes for Planet”, non-technological and social issues were successfully and explicitly integrated in the new P4Planet program, placing prominently non-technological issues for improving technology development and competitiveness (esp. through human resources and skills). 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 should be aligned very closely with two Permanent Working Groups (PWG) (see Figure 24):

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

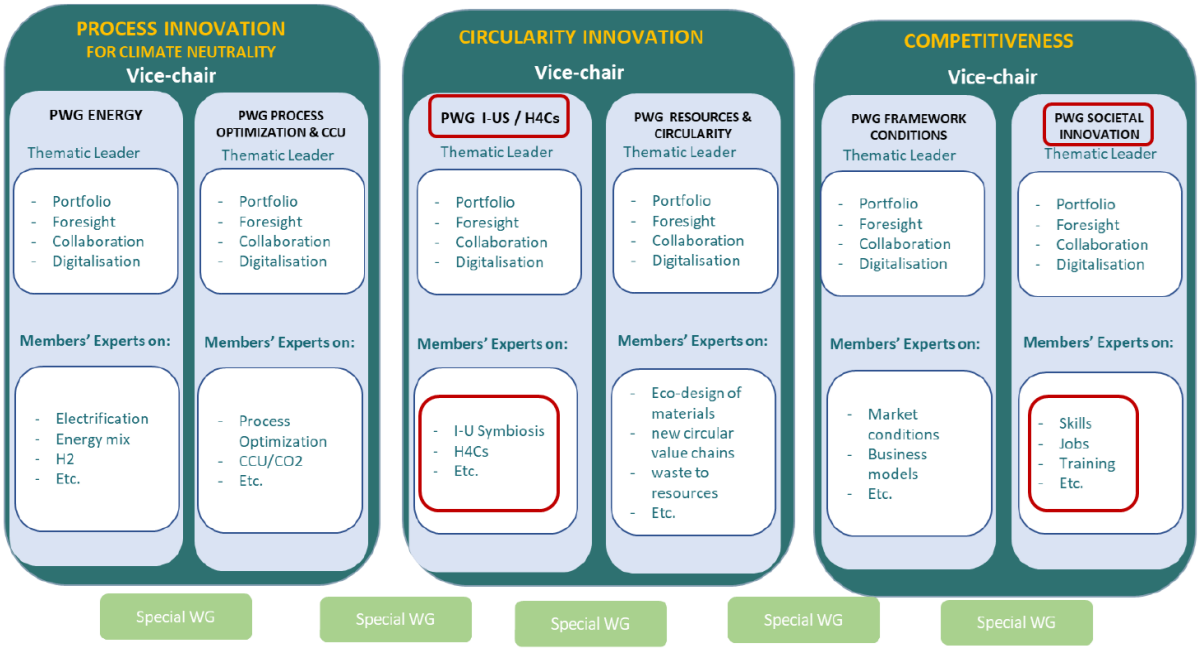


Figure 24: Planned Working Groups for Advisoring and Programming P4Planet

Ensuring a reliable cross-sector representation, SPIRE-SAIS established a "**Sector Representative Steering Committee**" (see table below) 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 SAIS Blueprint and Training Platform.

Table 6: Steering Committee "Sector Representatives"

Sector	Name	Partner	Function	Organisation
SAIS Coordination	Antonius Schröder	TUDO	Coordinator	Research
SPIRE	Angels Orduna	A.SPIRE	Co-coordinator	SPIRE Coordination
Non-ferrous Metals Aluminium	Christian Leroy	EU	Sector Representative	Aluminium, EU Association
Ceramics	Renaud Batier Ines Ferrao	Ceram-Unie	Sector Representative	Ceramics, EU Association
Minerals	Aurela Shtiza	IMA	Sector Representative	Minerals, EU Association
Chemicals	Anni Siltanen	ECEG	EU Employers Representative	Chemicals, EU Employers Association
Water	Andrea Rubini	Water Europe (WE)	Sector Representative	Water, EU Association
Cement	Koen Coppenholle	CEMBUREAU	Sector Representative	Cement, EU Association (associated partner)
Engineering	Valentina Colla	SSSA	Sector Representative	Engineering (partner)
Pulp & Paper (new)	N.N.	CEPI	Sector Representative	Pulp & Paper, EU Association (yet not formally participating, but invited as a visitor)
Refinery (new)	Damien Valdenaire	Concawe	Sector Representative	Refinery, EU Association
Raw Materials	Laurence Lamm	EIT Rawmaterials	Sector Representative	EU EIT (associated partner)
ESTEP	Klaus Peters	ESTEP	Sector Representative	Steel, EU Association (partner)
EUROFER	Miikka Nieminen	EUROFER	Sector Representative	Steel, EU Association
Union	Judith Kirton-Darling	industriALL	Representative Unions	(Global / European) Union (associated partner)
NGO	Agnese Ruggiero	Carbon Market Watch	Citizen Organisation	Global NGO (associated partner)

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

To connect SPIRE-SAIS with the national-regional level, we are focusing on a European-regional rollout strategy. Beside the European alignment with the P4Planet activities and coordination structures, especially the SPIRE-SAIS Training Platform should feed in the planned European Community of Practice of Industrial Urban Hubs for Circularity (HEU Call). With such a common European-regional platform, SPIRE-SAIS could foster IS training and skills development within the cooperating companies. Additionally, we could support regional coordination of the H4C by supporting a social innovation process of technological, economic, and social development within the regional Urban Hubs for Circularity: Serving and establishing not only online and on the job training framework 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 H4C regions by assuring tailor-made and pro-active adjustment of industry driven skills demands.

SPIRE-SAIS is aiming at establishing a European Training Platform connected with or incorporated in the forthcoming European Community of Practice (ECoP) for Hubs for Circularity. Within 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)), the SPIRE-SAIS European Training Platform could serve

proactive skills assessment and adjustment, analyse continuously and proactively skills gaps, provide up-to-date support and knowledge to energy intensive industries by collecting and developing up to date training modules and tools, related to the H4C regions in Europe. Via the ECoP a connection and networking of regions with H4C not only exchanging tools and knowledge across regions is guaranteed 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 should be 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 via the "Sector Representatives Steering Committee" (see Table 6) 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. This being said, they are the main actors for the planned rollout to the member states. This especially includes also industriALL as a European union, representing different sectorial and national trade unions of the member states. Additionally, we will look for other (national) stakeholder groups (policymakers, education system players, etc.), to be integrated during the rollout of the Blueprint.

4.1.4 European Networks and Projects

SPIRE-SAIS is approved partner of the European Pact for Skills, a flagship initiative of the European Skills Agenda. We will support the Pact 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 look forward to a cooperation beyond the SPIRE sectors. Already 22 partners signed the Pact for Skills on behalf of SPIRE-SAIS.

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 aims at 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 new (e.g. SPIRE Processes for Planet, SET Plan Action 6, Clean Steel Partnership) and already existing programmes (such as 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). As steel is one of the SPIRE sectors, we collaborate esp. with the European Steel Skills Alliance (ESSA), SUSTAIN steel project, and the Clean Steel Partnership (CSP) of ESTEP, 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, SPIRE-SAIS is based on the analysis of recently 184 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, 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 is inspiring our networking activities with its training program and INSIGHT results will be used for establishing the profile/occupation of the IS Facilitator as part of our training platform and framework.

During the rollout phase of SPIRE-SAIS to the regional level, beside the ECoP U-IS/H4C, cooperation with other European or sector specific platforms will be examined. Esp. with the European Cluster Collaboration Platform and their sector related clusters: e.g. steel, ceramics, water or engineering.

Needless to say, that during our activities we will integrate further relevant networks and projects.

4.1.5 European Programs, Initiatives and Tools

European skills related programs are of utmost importance for 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 will use and integrate EU instruments and tools related to skills and occupations such as ESCO, EQF, ECVET and EQAVET as much as possible. We will refer to the learning outcomes approach, linked with credit points of ECVET and ECTS to promote 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). A database of job profiles and occupations (see forthcoming Deliverable D5.1, Annex) related to Industrial Symbiosis and Energy Efficiency will be also 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 as well in the implementation and test phase in 2022, based on the outlines of the job profiles and occupations and their alignment with the ESCO database. ESSA partners are participating in the 3rd phase of the ESCO pilot project for linking learning outcomes of qualifications to ESCO skills.

European initiatives like the Circular Cities and Regions Initiative (CCRI) and the European Circular Economy Stakeholder Panel (ECESP) will be 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 Processes for Planet, Clean Steel and HORIZON Europe cluster 4, 5, 6 will be inspired by SPIRE-SAIS partners and results continuously.

4.2 Alliances and Leadership

Foundation for the sustainable alliances and leadership of SPIRE-SAIS is the project partnership built on and with support of the existing SPIRE coordination (A.SPIRE), projects and activities. Already in its proposal phase, with a cross-sectoral approach covering all the SPIRE energy intensive industry sectors, SPIRE-SAIS was composed by main European stakeholders, integrating steel companies, education and training providers, associations and social partners, and research institutions of the energy intensive industry sectors. The new 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 below). A strong integration in the SPIRE Community, its 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. 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), The European Chemical Industry Council (CEFIC), 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.

- **Industry sector associations**: A.SPIRE, ESTEP, IMA Europe, European Aluminium, Water Europe, ECEG
- **Companies**: Covestro (Chemicals), Sidenor, Ferriere Nord (Steel), MYTILINEOS (Aluminium), Suez (Water), ArcelorMittal (Mining)
- **Education/training providers & RTOs**: Scuola Superiore Sant'Anna, Fundation Circe, ITC, ISQ, International Synergies, H2Opeople
- **Research institutions**: TU Dortmund University, CSM/RINA, Visionary Analytics, IMNR, Łukasiewicz-IMN
- **Regional institutions**: ART-ER
- **Associated partners**: industriALL, EIT Raw Materials, thyssenkrupp Steel Europe, CEFIC, CEMBUREAU, ITQ (Universitat Politècnica de València), Carbon Market Watch, Circle Economy, University of Deusto, Mota Ceramics, ARGO Science Park, Skillman.

Figure 25: 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 will systematically link the European Blueprint with the European, national, and the regional level of Hubs for Circularity (see Rollout of the Blueprint, next chapter). 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 SPIRE activities and events. Via A.SPIRE (the SPIRE-SAIS co-coordinator and the coordination unit of the public-private partnership SPIRE under Horizon Europe) and its main coordination activities (e.g. Strategic Innovation and Research Roadmap 2050, Processes for Planet, General Assemblies, Workshops like Hubs4Circularity) almost all partners are involved in these activities, not at least because they are members of 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 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 (still under consideration). Additionally, presentations or panel participations within the Circular Economy Stakeholder Conference, the European Innovation Days, Vocational Skills Week, Citizen Engagement Festival, 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 19) the Skills Alliance will be run by the Skills Intelligence Hub for Industrial Symbiosis and the related Training Community. Therefore, the SIHub has to be 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 Aluminum, European Chemical Employers Group (ECEG), The European Chemical Industry Council (CEFIC), 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 planned 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 European Pact for Skills to the broader community of different sectors and the other sectoral Blueprints

- Social Partnership: Via the sector associations and industriALL to the different industry sectors and member states.

This coordination structure (see an illustration in the Figure below) will be further developed with the relevant stakeholders and leaders in the implementation and test phase 2022. 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 have to be initiated and launched, as well as internal integration of skills adjustment within the activities of the associations, unions, companies, and training providers.

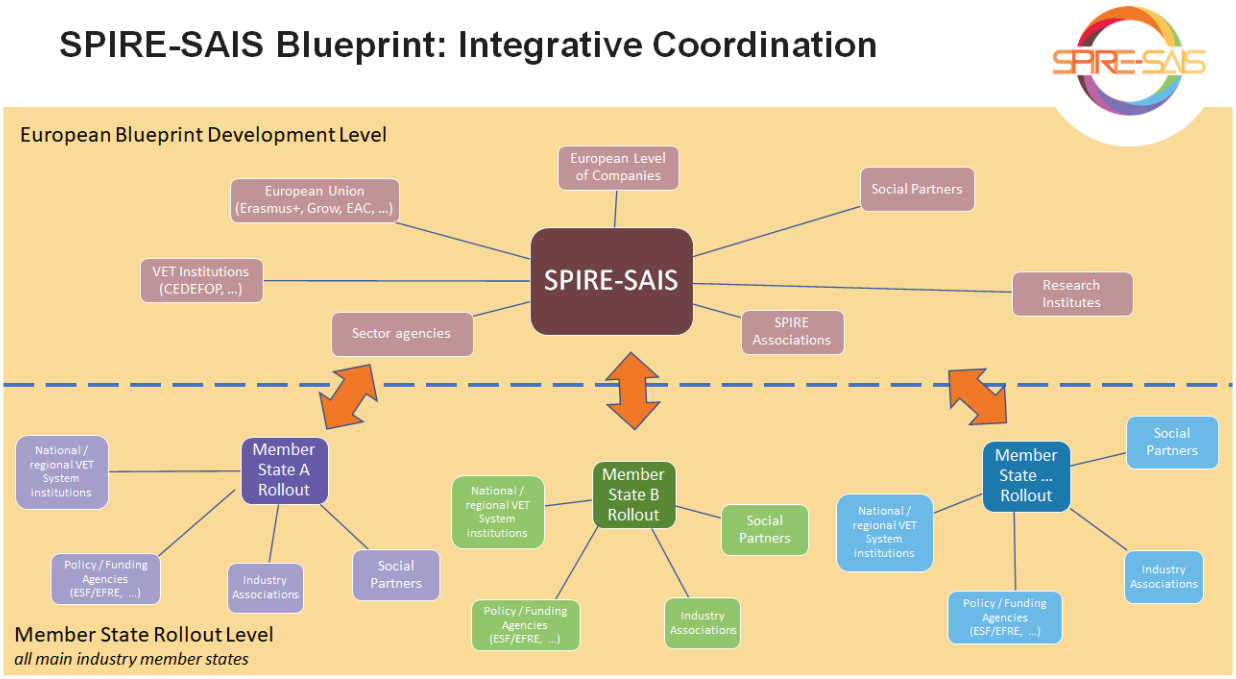


Figure 26: European-sectoral-national Coordination of SPIRE-SAIS

5 Rollout

As already becoming evident in the SPIRE-SAIS Alliances and Leadership approach, the rollout of the Blueprint is already part of the existing partnership and activities, being European, sector related, national and regional (see the approach illustrated in the Figure below). Applying the well-known European Open Coordination method SPIRE-SAIS will coordinate the skills adjustment via its Skills Intelligence Hub and Training Platform on the European level in cooperation / alignment with the SPIRE community and the planned European Community of Practice of Industrial Symbiosis (European level). Additional to these organisations (SPIRE and ECoP), 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 partnership. SPIRE-SAIS is engaging the sector associations as nodes to the (national) members of their specific sectors (Chemical, Water, Ceramics, Raw Materials, Cement, Railway Supply, Non-ferrous Metals, Minerals, Engineering, Refinery, Pulp and Paper).

Doing so, important companies and training providers of these sectors are already informing their plants, partners and contacts about SPIRE-SAIS measures, trainings, and tools. The national, member state rollout will be focused on Industrial Symbiosis regions (planned or running) and should be done in a concerted action with ECoP, SPIRE, Pact for Skills and other sectoral Blueprints, engaging public VET and HE authorities.

As said, the member state rollout should be focused or based on the regional Hubs for Circularity level, because of the practical and pressing relevance of skills for implementing and running urban or regional Industrial Symbiosis. Competence is needed to set up and start Industrial Symbiosis Ecosystems, integrating technological, educational, and social/societal development with a broad range of stakeholders from industry, education and research, policy, and (not to forget) civil society to improve environmental sustainability in the region where people live, work and learn, in a continuous and sustainable development process.

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.

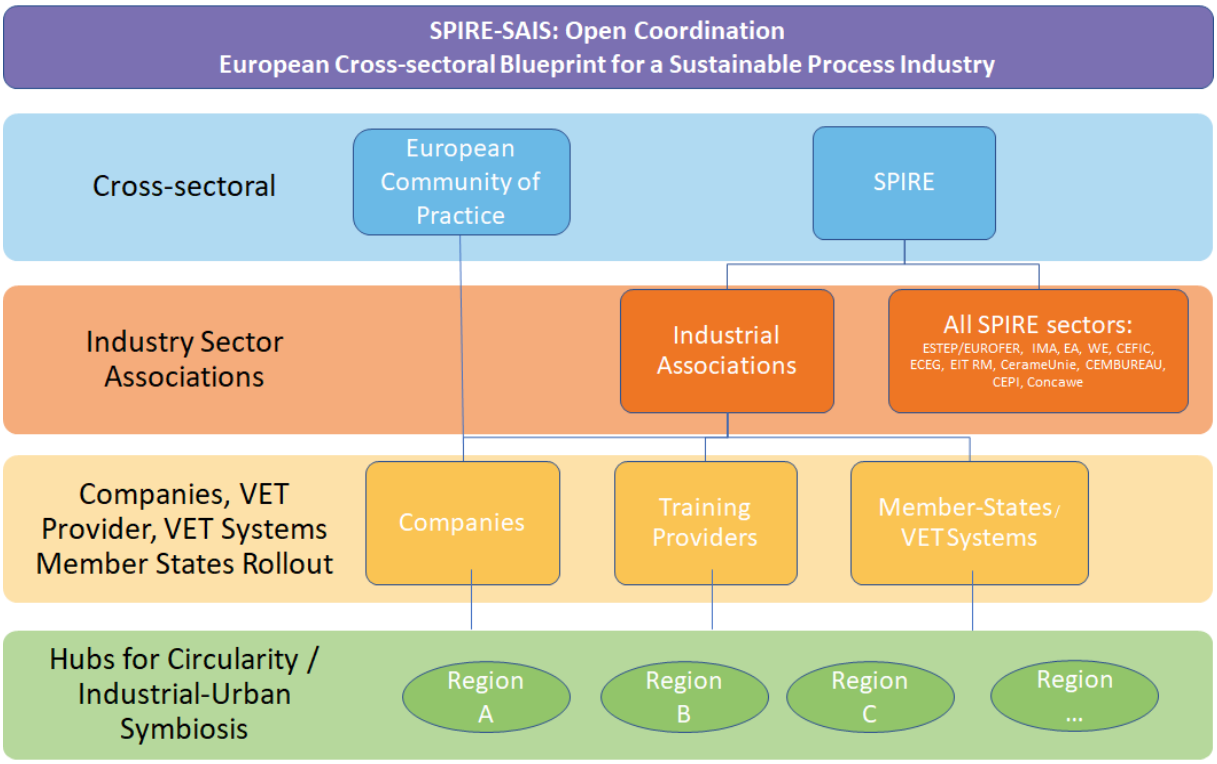


Figure 27: European-sectoral-national-regional Rollout with Open Coordination

Rollout (and dissemination) activities were already done by the partnership since the project started and will 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 (Deliverable D8.1; Almeida & all WP leaders, 2020) and Annual Evaluation Reports (Deliverable D8.2; Almeida, 2020). With these instruments we are able to demonstrate how effectively the project is reaching its objectives, getting close to its desired outcomes and what are the shortages and weak points identified by partners to be improved (SPIRE-SAIS as a social innovation process, see Figure 4).

Targeted rollout activities will include (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. However, the implementation (Deliverable D6.1) and exploitation plan (Deliverable D6.3) (due in 2022) will 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 in line with the Hubs for Circularity of the new SPIRE program "Processes for Planet", 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 28).

Figure 28: Industrial Symbiosis on the Regional Level (Example ARGO)

The exploitation and rollout strategy to the member states and regions will focus first on countries reached out and represented in the project and setting up a European Open Coordination Framework to integrate all the relevant member states and regions. Workshops and Dialogues with policy makers are planned to facilitate an effective rollout of the Blueprint. With national and regional VET institutions, not only the strategy but also the implementation process will be developed together, setting the ground for a national / regional adaptation and rollout after the end of the project. European and national financial resources (e.g. EFRE or ESF) have to be identified to implement, adopt and adjust the Blueprint to the national framework and conditions.

6 Steps Foreseen

First of all, due to the cyclic concept and social innovation process of SPIRE-SAIS, all the existing elements, deliverables, tools, and measures will be further developed and improved by new insights, databases and repositories will be added with new elements: Namely a job profile related skills assessment (skills gaps, current and future proficiency levels) and a job profile database improvement (connected with ESCO/ISCO occupations and the related VET database).

Within the first implementation and testing phase 2022 the necessary parameters for a sustainable integration and alignment of SPIRE-SAIS and its main elements (SIHub and Training Platform) with the described existing European and national/regional structures will be elaborated, establishing interrelated Alliances and Leadership on the European and sectoral level, fostering joint Blueprint activities and setting the ground for a national/regional rollout. Special attention has the organisational integration and sustainable running of the Training Platform.

Furthermore, we will examine in how far pilot training tools, measures and arrangements are reaching out to the target groups, how far they have to be improved, adjusted or (if necessary) generally changed. Within this test environment, additional, more specific and further needed training offers will be checked, esp. train the trainer modules, to be integrated or improving the Training Platform. More pilot training modules and offers from the sectors and training providers will be collected and integrated. Especially didactical measures will be examined, combining on the job, on-site training in companies and VET schools with online training.

Beside the already running cooperation with ESCO, the Blueprint will engage with other European tools, such as ECQA (European Certification and Qualification Association) for certification of industrial symbiosis related skills and training modules, the Pact for Skills and the CEDEFOP Skills Intelligence Platform to exchange our results with the broader education and industry community, and Europass to collect learning outcomes for the individual learner.

The Skills Intelligence Hub for Industrial Symbiosis will be implemented as a central coordination unit, to be aligned with existing European industry sector structures. The SIHub will bundle all the necessary activities to (a) monitor and evaluate regularly technological and economic developments and related industry skills requirements for Industrial Symbiosis (Foresight Observatory, Technology and Skills Radar), and (b) to ensure the alignment and support the European IS Training Community.

Reducing the foresight observation to a manageable set of indicators, a regular (bi-)annual foresight survey (Technology and Skills Radar) based on the questionnaire already developed will be elaborated and tested, esp. against the background of the acceptance of the sectors.

Moreover, additional indicators, recommendations, (self) assessment tools, and incentives will be developed, engaging and supporting companies, training and education providers, associations and social partners, public education authorities to *find their place in the SPIRE-SAIS Skills Alliance*. Additional tasks of the SIHub for 2022 comprise the formulation of policy recommendation and claiming policy support, allowing a place for pilot measures and tests, incentives, dividing responsibilities and leadership, and not at least launching and conducting campaigns concerning esp. image, recruitment, and talent management.

For the test and rollout phase 2022/23 an implementation (Deliverable D6.1) and exploitation plan (Deliverable D6.3) will be developed setting the ground for the sustainability of the Blueprint Alliance and gathering first experiences of rollout strategies and possibilities at sectoral,

national and regional level. Beside the European (SPIRE and its sector associations) the regional level in line with the ECoP and Hubs for Circularity of the new SPIRE program “Processes for Planet” will be of high attention and relevance for SPIRE-SAIS.

7 Annex

7.1 List of Abbreviations

Abbreviation	Meaning
CVET	Continuing Vocational Education and Training
ECVET	European Credit System for Vocational Education and Training
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
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
FP6	Sixth Framework Programme
FP7	Seventh Framework Programme
H2020	Horizon 2020
H4C	Hubs for circularity
HE	Higher Education
HEU	Horizon Europe
IS	Industrial Symbiosis
ISCO	International Standard Classification of Occupations
IVET	Initial Vocational Education and Training
KPI	Key Performance Indicator
LCA	Life Cycle Assessment
MFA	Material Flow Analysis
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
SET	Strategic Energy Technology
SIHub	Skills Intelligence Hub
SMART	Specific, Measurable, Achievable, Realistic and Time-bound
SME	Small and medium-sized enterprises
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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7.3 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

7.4 Facts and Figures

7.4.1 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)

7.4.2 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

7.4.3 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

7.4.4 MINERALS SECTOR

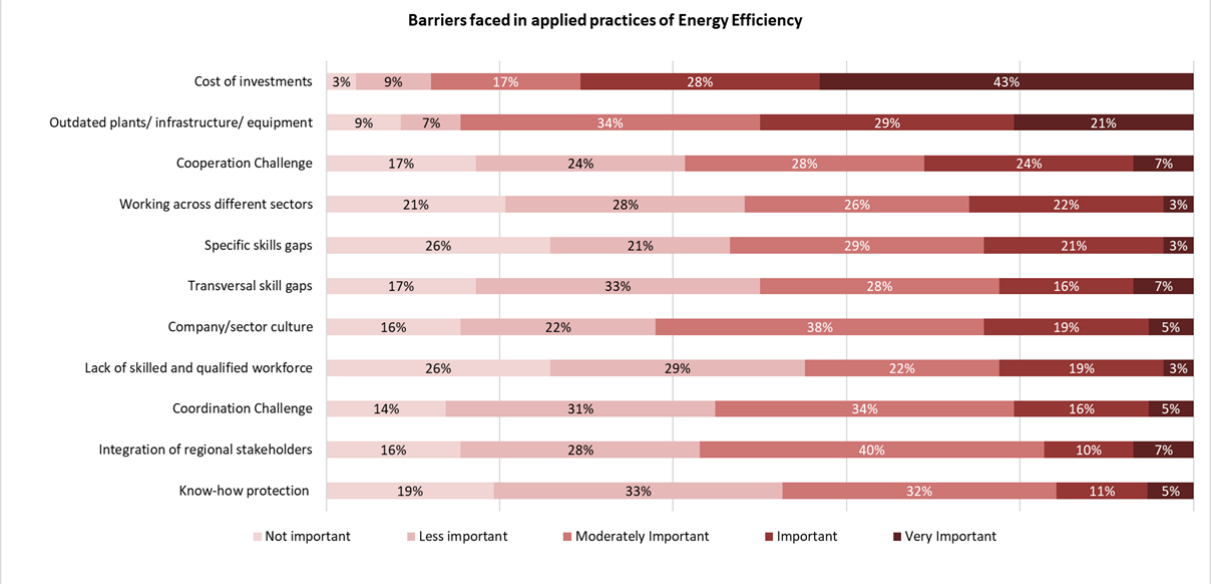
	**MINERALS**
SUBSECTORS 	Minerals sector association covers and represent the interests of multiple minerals such as: andalusite, bentonite, borates, calcium carbonate (precipitated and ground), diatomite, dolomite, feldspar, limestone, lime, kaolin, plastic clay, sepiolite, magnesite, silica sand and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

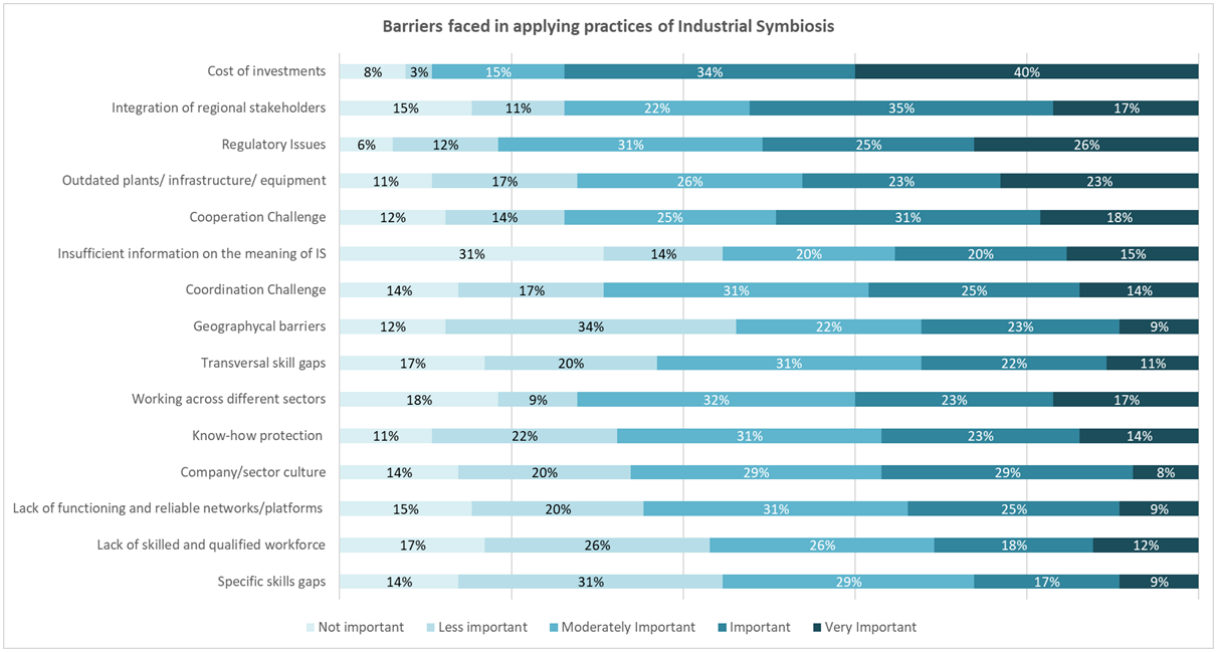
DIRECT JOBS 	47500	**PRODUCTION (€)** 	15 bn
ENERGY 	To extract and process minerals there is need for energy and fuels. The sector has demonstrated via the various Life Cycle Inventories that the energy consumption and the carbon footprint are reduced over the years.		
EMISSIONS 	The process emissions 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).

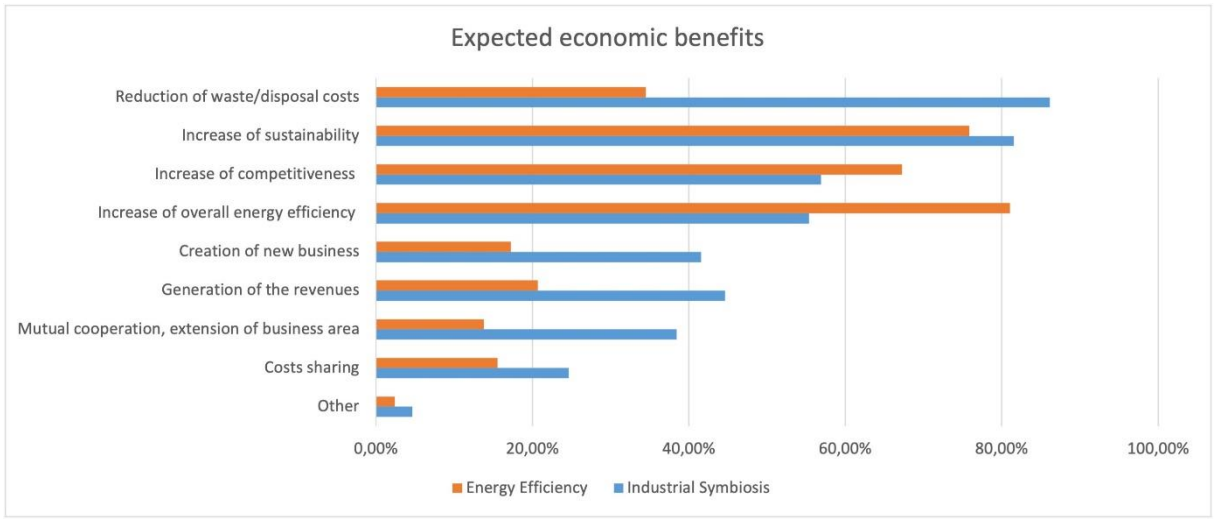
7.5 Detailed Figures

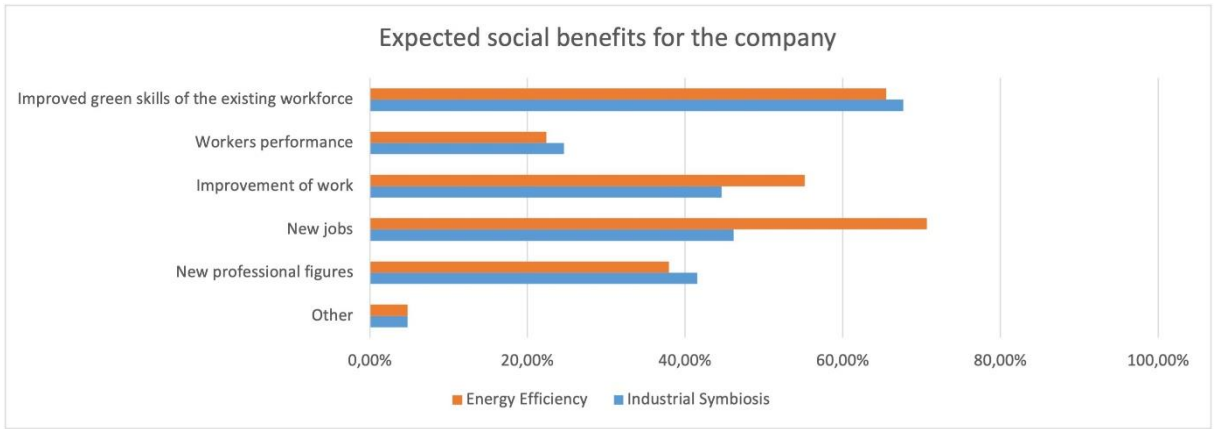
(a) Barriers Faced in EE and IS





(b) Expected economic and social benefits





(c) Skills assessment (examples Energy Manager)

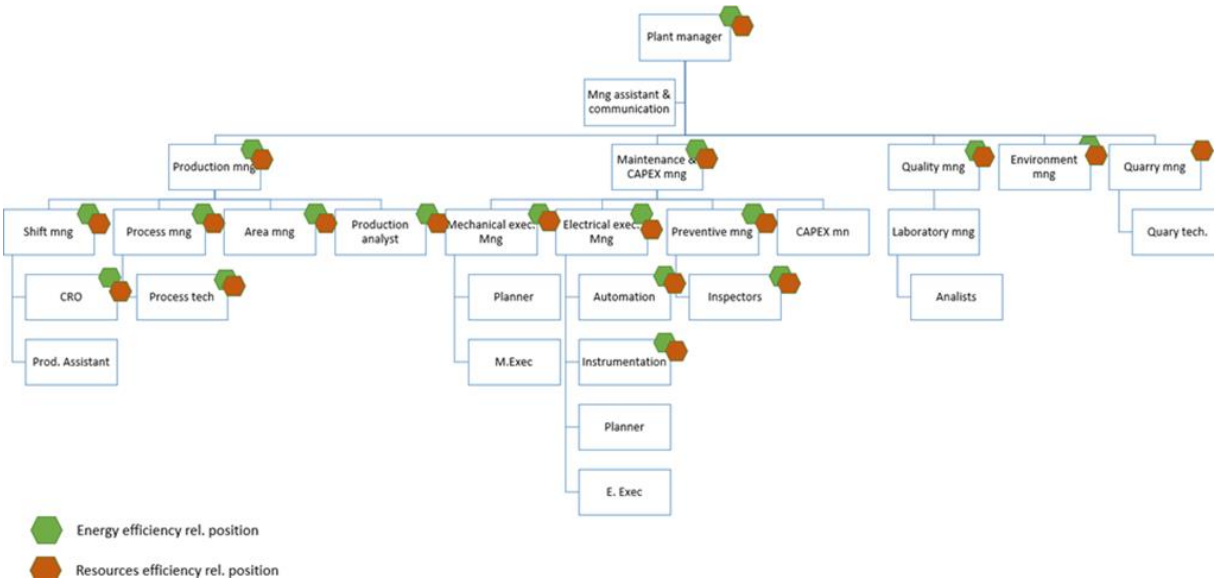
PROFILE TITLE	Energy Manager		
ISCO Code	1349.12		
Mission	Energy managers coordinate the energy use in an organisation, and aim to implement policies for increased sustainability, and minimisation of cost and environmental impact.		
TASKS	Current	Future	
Main task/s	adhere to organisational guidelines 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		

(d) Skills assessment (example Liquid Waste Treatment Operator)

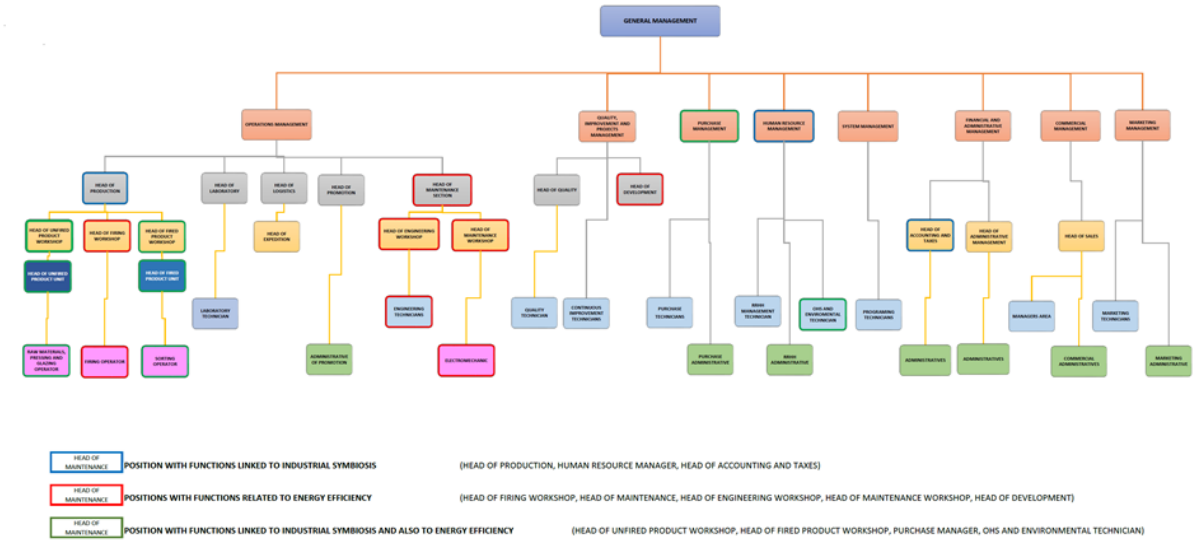
PROFILE TITLE	Waste Management Technician (Liquid Waste Treatment Plant Operator		
ISCO Code	3132.2		
Mission	Liquid waste treatment technicians remove hazardous chemicals and pollutants from liquid waste such as oil so that it can be safely used for new applications. They operate and maintain liquid 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		

7.6 Sectoral Organisational Flowcharts

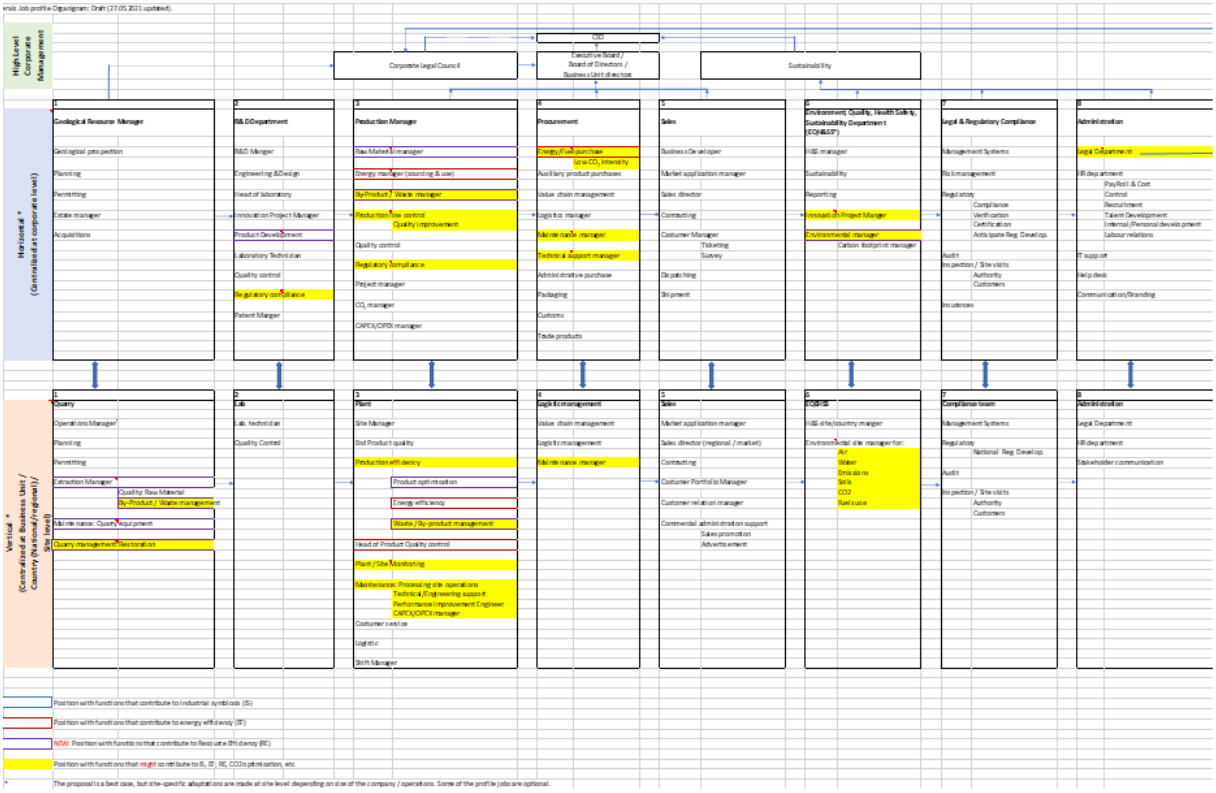
7.6.1 Cement



7.6.2 Ceramics

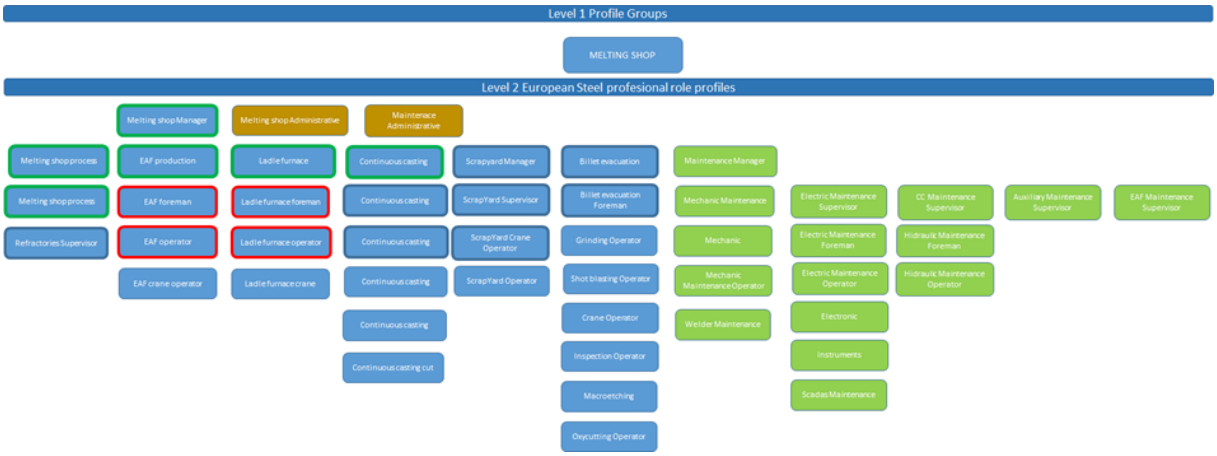


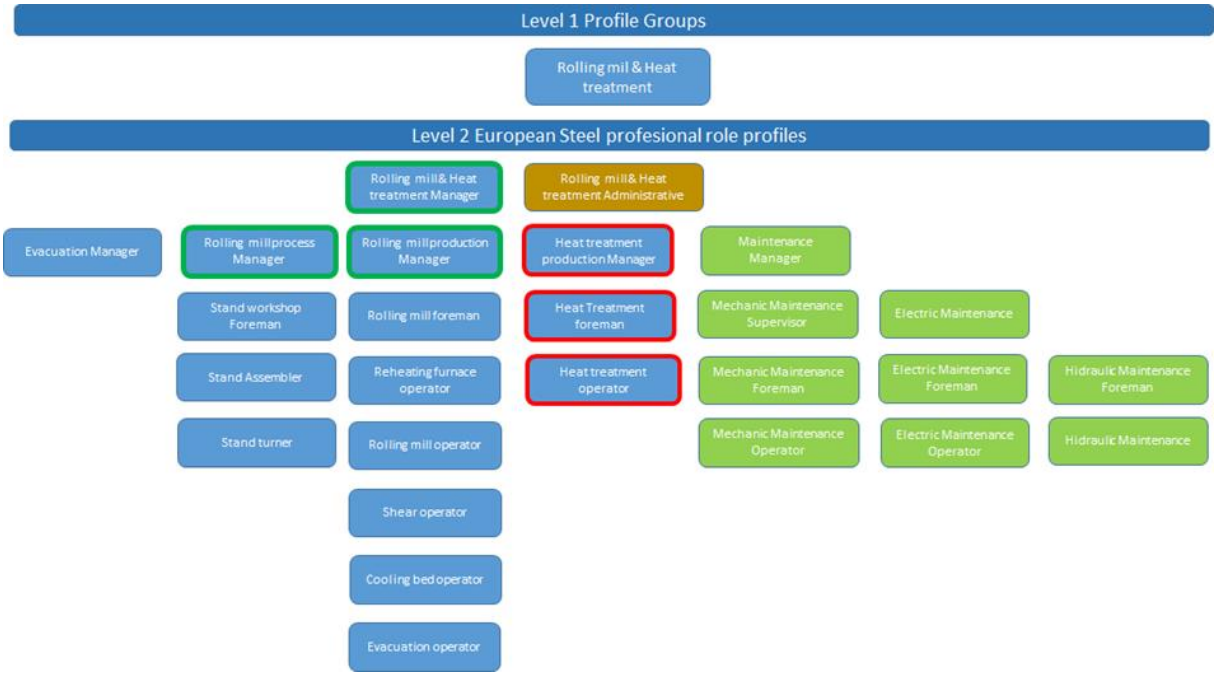
7.6.3 Minerals

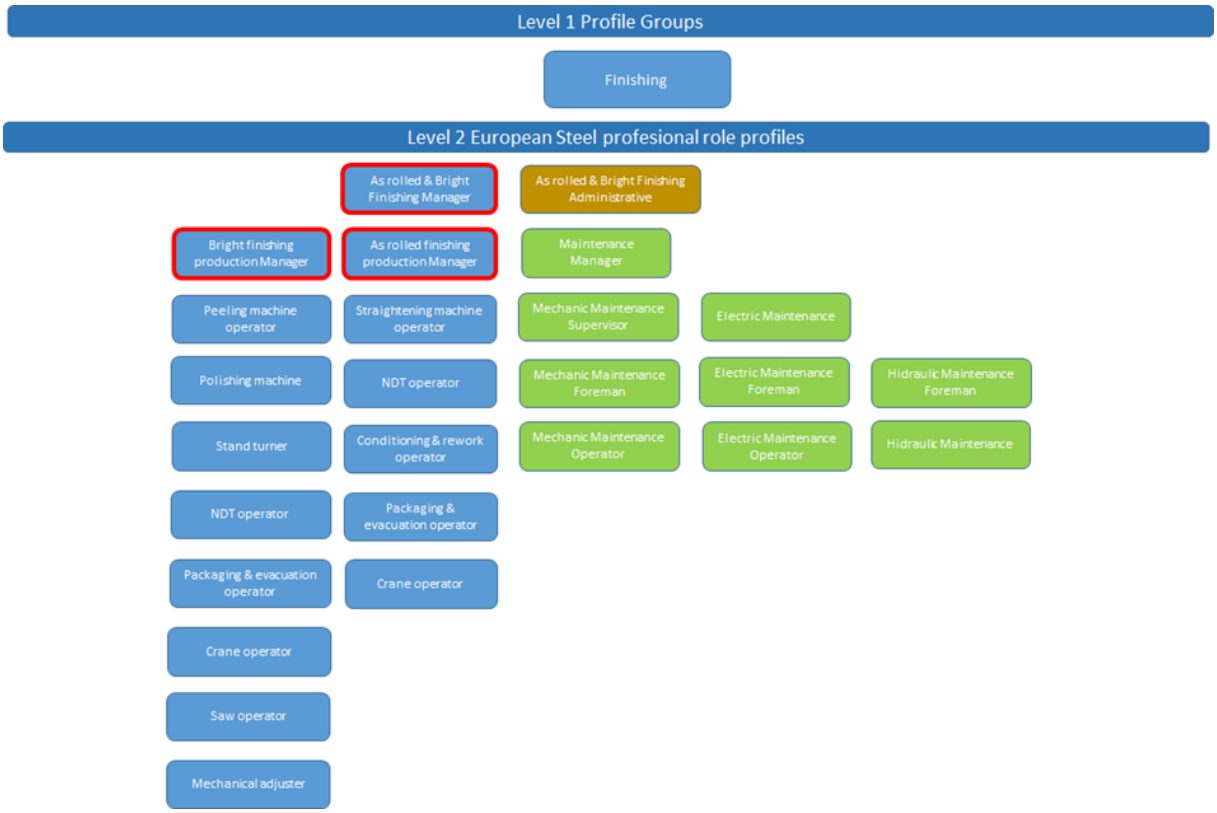


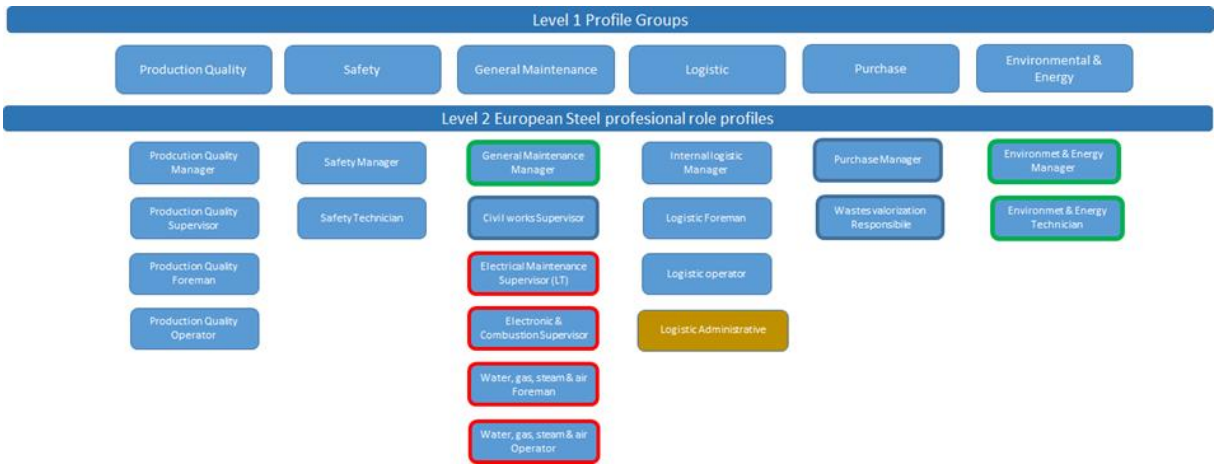
7.6.4 Steel

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

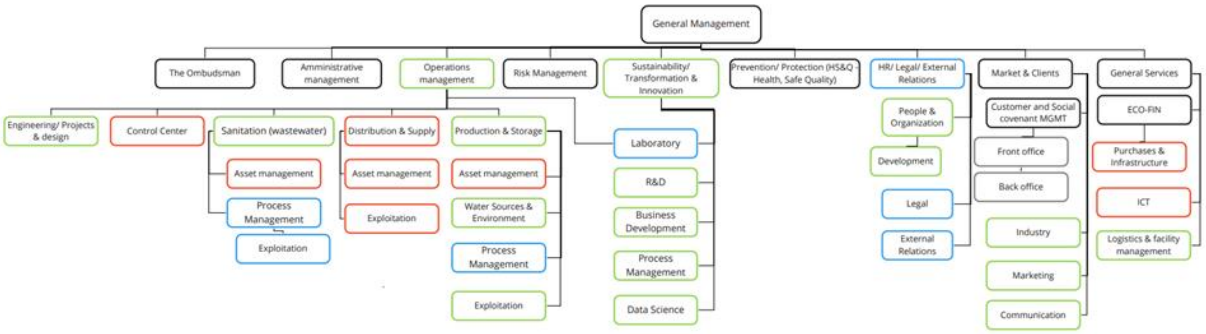

Level 1 Profile Groups
MELTING SHOP
Level 2 European Steel profesional role profiles
Melting shop Manager
Melting shop Administrative
Maintenace Administrative
Melting shop process
EAF production
Ladle furnace
Continuous casting
Scrapyard Manager
Billet evacuation
Maintenance Manager
Melting shop process
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
Safety Manager
General Maintenance Manager
Internal logistic Manager
Purchase Manager
Environmet & Energy Manager
Production Quality Supervisor
Safety Technician
Civil works Supervisor
Logistic Foreman
Wastes valorization Responsibile
Environmet & Energy Technician
Production Quality Foreman
Electrical Maintenance Supervisor (LT)
Logistic operator
Production Quality Operator
Electronic & Combustion Supervisor
Logistic Administrative
Water, gas, steam & air Foreman
Water, gas, steam & air Operator

7.6.5 Water


General Management
The Ombudsman
Amministrative management
Operations management
Risk Management
Sustainability/ Transformation & Innovation
Prevention/ Protection (HS&Q Health, Safe Quality)
HR/ Legal/ External Relations
Market & Clients
General Services
Engineering/ Projects & design
Control Center
Sanitation (wastewater)
Distribution & Supply
Production & Storage
Laboratory
People & Organization
Customer and Social covenant MGMT
ECO-FIN
Asset management
Asset management
Asset management
R&D
Development
Front office
Purchases & Infrastructure
Process Management
Exploitation
Water Sources & Environment
Business Development
Legal
Back office
ICT
Exploitation
Process Management
Process Management
External Relations
Industry
Logistics & facility management
Exploitation
Data Science
Marketing
Communication

7.6.6 Chemical