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

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Remark

There are overlaps and double text passages with other SPIRE-SAIS Deliverables (esp. D5.1 Training Framework and D5.3 Blueprint). This was done due to the possibility that readers will not read all of these Deliverables, integrating relevant information for understanding the frame of this overarching Final Report, summarising all the other Deliverables of SPIRE-SAIS.

Content

Introduction

This report summarises the progress and final results of the European Skills Alliance for Industrial Symbiosis - Cross-sectoral Blueprint for a Sustainable Process Industry (SPIRE-SAIS) and its implementation strategies across its development phases:

Phase 1: Identifying skills requirements and basics for establishing the Blueprint (WP 2, 3, and 4), first contours of the Blueprint (WP5)

Phase 2: Reflecting the first research results and network development with the project partners and sector associations, policy, social partners, European and national representatives (WP6, 7)

Phase 3: Upgrade of the research results of phase 1 (WP 2, 3, 4), implementing a Blueprint Prototype of the European Skills Alliance for Industrial Symbiosis (WP5).

Phase 4: Reflecting the upgraded research results and networks approach as well as the comprehensive European skills strategy with the involved industry associations, policy makers, social partners, European and national representatives, setting the ground for the future sustainable strategy (WP6, 7)

Phase 5: Optimisation and finalisation of a concerted European Blueprint in line with national skills agendas for anticipating skills demands and fostering smart, inclusive and sustainable growth (WP5).

Starting with (1) the SPIRE-SAIS overview, objectives and methodology, (2) the results of the technological and economic development will be summarised as a background for (3) the industry skills demands and (4) VET system requirements. Against this backdrop, (5) outlines of the European Blueprint will be presented as well as (6) its transfer and implementation strategies. Finally, policy recommendations and dissemination activities (7) are listed, finalised by a summary of the current status of the SPIRE-SAIS Blueprint and Alliance and next steps foreseen (8).

In line with the strategies and measures of the European Commission "New Skills Agenda" and its “Sectoral Blueprints”, SPIRE-SAIS is especially committed to the “Green Deal” and the "Twin Transformation: Digital and Green", the "Pact for Skills" (especially by the integration of SPIRE-SAIS in the Large Scale Partnership Energy Intensive Industries (LSP EII)) and as well with existing European tools and measures (such as EQF, ESCO, ECTS, EQAVET, Europass, and ECQA). Concerning Energy-Intensive Industries we are strongly engaged in integrating the skills perspective in the “Processes4Planet” programme via A.SPIRE’s Permanent Working Group “Societal Innovation”.

Executive Summary

Beside getting a common perspective on the Blueprint and the involvement of the different sectors and stakeholders (WP1), the Blueprint and the Training Framework (WP5) as well as the policy recommendations (WP7) have been developed against the background of the technological development (WP2), the industry skills requirements (WP3), and the VET system support (WP4) for needed Industrial Symbiosis and Energy Efficiency related skills. The integration of SPIRE-SAIS in the Large Scale Partnership Energy Intensive Industries (LSP EII) under the European Pact for Skills is a big step forward to continue with these results.

Technological and economic development (WP2)

With an analysis of 280 current innovation projects and numerous documents completed by a company survey (81 valid responds), the technological and economic development concerning Industrial Symbiosis and Energy Efficiency in the SPIRE sectors and first impacts on the workforce were elaborated. This led to an overview on management and operating skills: with differentiations and similarities for Industrial Symbiosis and Energy Efficiency, mainly with the common need of an incremental up- and reskilling of the workforce, and exposing the need for an “IS Facilitator” as a new job profile.

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 is 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 and 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:

(a) 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.

(b) 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, MFA (Material Flow Analysis) & LCA (Life Cycle Assessment), Marketing, and IT skills.

(c) Energy Efficiency skills: 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.

Additional to the desk research, a company survey across the different sectors reflects that the current level of technological implementation is higher for EE rather than for IS, although companies perceive IS and EE as an important opportunity emphasising their efforts in the future toward both the topics. Moreover, some barriers belong to implementation practices and perception of solutions generating 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. Currently the level of skills is stated to be generally lower for IS than for EE. In addition, 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 activities. 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.

Industry Skills Requirements (WP3)

Based on the results of the technological development and related skills demands (WP2), a methodology for identifying and classifying skills was developed, starting with facts & figures and organisational flowcharts of six of the involved sectors. Against this backdrop, job profiles related to Industrial Symbiosis, Energy Efficiency, or both (including both intermediate management levels and blue-collar profiles) were identified, out of which 22 generic ones were selected across the sectors. A first selection of 65 related skills was prioritised, condensed and classified to a set of 22 skills. The selected 22 generic job profiles were interlinked with 22 related ESCO occupations.

In order to achieve the described goals and to deliver a sound input for the Blueprint, skills needs (current and future) in term of four proficiency levels and learning outcomes were defined, redefining professional profiles. Via the Learning Outcome Pipeline Methodology, a cohesive and structured link between industry requirements and educational formal occupations was established.

In a survey 2024 the selected job profiles and skills classification were endorsed. Additionally, the evaluation of the survey led to useful information how to setup the planned skills intelligence tool “Technology and Skills Radar”.

VET System Support (WP4)

Mapping of current VET provision for Industrial Symbiosis and Energy Efficiency skills of the Energy Intensive Industry sectors took place in five selected member states: Germany, Spain,

Italy, Poland, and Portugal. 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 fragmentation of the responsibility for green skills delivery and a missing overarching strategy, while funding tends to be fragmented and short-term as well.

With a combined matrix of cross-sectoral Industrial Symbiosis and Energy Efficiency skills, SPIRE-SAIS tends to “connect” different concepts including job profiles, occupations, and qualifications and to identify how Industrial Symbiosis and Energy Efficiency related skills needs are addressed in relevant VET programmes. The therefore developed matrix combining the industry job profile perspective with (formal) qualifications of the VET system, aligned with European programs like ESCO and EQF. It maps the highlighted job profiles (Energy Manager, Energy Technician, Waste Manager, and Waste Technician) and skills relevant to IS and EE, aligning them with EU frameworks and assessing their integration into national VET systems (Italy, Germany and Portugal). The matrix was integrated into the SKILLS4Planet online platform. It includes a Learning Solutions Directory, Skills Directory, and Qualifications Section, providing educational resources and detailed qualifications for the Energy Intensive Industries (EIIs). It helps align industry needs with VET provisions and facilitates international employee mobility. The work done on national EQF qualifications related to IS and EE emphasised the need for continuous updates of the platform, regarding qualifications, profiles, and training courses to maintain a relevant and effective skills framework.

European Blueprint (WP5)

The SPIRE-SAIS Blueprint addresses industry skills demands through the establishment of Skills Intelligence via a Foresight Observatory, an Online Training Platform (SKILLS4Planet), and a planned European Training Community for Industrial Symbiosis. This involves continuous observation of technological, economic, and societal demands to develop strategies and measures, supported by new or existing alliances and leadership. The Blueprint encompasses demand, supply, and coordination aspects.

The SKILLS4Planet platform is a centralized digital platform that supports continuous skill updates and training, offering interactive and open online training courses, pilot measures, incentives for best practices, and industry image campaigns for recruitment. It includes a Skills Directory, Capability Assessor, Learning Solution Directory, Qualifications Directory, and Micro-Credentials, while providing a flexible IT infrastructure and integration options for various organizations and individuals.

Recruiting skilled workers for energy-intensive industries is challenging, but tools like the SKILLS4Planet platform and SPIRE-SAIS rollout offer valuable solutions. These efforts address skills gaps, foster regional collaboration, and focus on continuous workforce development, improving talent attraction and retention and contributing to a more sustainable and competitive industry.

The SPIRE-SAIS Blueprint aims to meet industry skill demands through a comprehensive strategy involving continuous observation, skills intelligence, and training platforms. Key elements include:

- **Skills Intelligence and Foresight Observatory:** Regularly updates on technological and economic demands and skills requirements.
- **Training Framework and SKILLS4Planet:** An online platform offering interactive training courses and resources for Industrial Symbiosis and Energy Efficiency.
- **Image and Recruiting:** Campaigns to attract talent to the process industry.
- **European Coordination:** Aligns new alliances and governance with existing European structures and ensures sustainable implementation.

The Blueprint focuses on demand-driven skills adjustment, proactive and sustainable strategies, and fostering cooperation among stakeholders to enhance human resource capabilities in technological development. It thereby integrates training with real workplace needs and ensures sustainability beyond the project lifespan through business models and market orientation.

Transfer and Implementation of the Blueprint (WP6)

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

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

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

Therefore, the pilot rollout workshops are only a first step. They have to be continued and extended. As the rollouts for the aluminium sector and the ceramics sector are planned for the second half of 2024, it shows the need for continuity beyond the project life span. Especially the further integration of the SPIRE-SAIS Blueprint and the European SKILLS4Planet Training Platform within further regions and sectors should lead to an incorporated European Community of Training Practice (ECoP). Within regional training ecosystems (including public authorities and policy, big companies and SMEs, social partners, educational organisations and training providers, as well as civil society organisations), the SPIRE-SAIS European Training Platform could

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

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

Policy Recommendations and Dissemination (WP7)

Dissemination activities were and will be continuously done, starting already before the project officially began and continued throughout its duration, with a plan to continue spreading results and policy recommendations and running the SPIRE-SAIS website continuously as part of the A.SPIRE homepage, ensuring ongoing visibility, updates on progress, and integration among stakeholders. Results were presented at various events, including workshops, conferences, and webinars, involving key stakeholders and policymakers. An intermediary online conference (March 2022) and a final conference in Dortmund (May 2024) showcased results and the SKILLS4Planet training platform.

Policy Recommendations comprise general and overarching ones, European, National and Regional, as well as company level ones to address the different stakeholders).

With this SPIRE-SAIS achieved significant dissemination through various activities, also adapting effectively to challenges posed by the COVID-19 pandemic. The developed policy recommendations aim to integrate skills adaptation into strategic policies and provide tools for continuous improvement in green skills training across different levels.

Large Scale Partnership Energy Intensive Industries under the European Pact for Skills

Sustainability of SPIRE-SAIS is given by founding the Large Scale Partnership Energy Intensive Industries (LSP EII) under the Pact for Skills, pushed and established by SPIRE-SAIS and ESSA in May 2023. With the LSP EII, a common all energy-intensive process industries comprising framework and alliance was created based on the alliances and results of the two Blueprints SPIRE-SAIS (cross-sectoral and Industrial Symbiosis skills specific blueprint) and ESSA as a specific (steel) sector-related blueprint including an incremental upskilling of representative job profiles (t-shaped skills: technical and transversal skills (green, digital, social, individual, and methodological)). The LSP EII is not only ensuring the exploitation of SPIRE-SAIS (and ESSA) results, measures and tools, but also bringing the development forward to a higher level by compiling synergies of both blueprints and extending the focus to additional sectoral and regional in-depth trainings, rollouts, and marketing activities.

Within the LSP EII SPIRE-SAIS contributes to the European Green Deal and the EU´s Twin Transition, as well as to the New Skills Agenda for Europe and the new concept of Industry 5.0. Complementarity and essential input to industry related EU programmes will be ensured through the stakeholders involved: namely Net-Zero Industry Act, Critical Raw Materials Act, Processes4Planet, Clean Steel Partnership, SET Plan Action 6, CoP Industry 5.0. Obviously, skills related engagement with other Sectoral Blueprints (e.g. Hydrogen, Automotive, Advanced Manufacturing, Batteries) and the Pact for Skills is central as well. Cooperation with and contributions to CEDEFOP's Skills Intelligence programme and cross-linking with the ESCO database are key as in the use of skills related results and outcomes from other European projects.

1 The SPIRE-SAIS Project: Background, Objectives, Approach, and Methodology

The identification and anticipation of skill needs is a core European objective for many years (e.g. Maastricht and Helsinki Communiques (Council of the European Union, 2004, 2006b); the European Council's integrated guidelines for employment 2005-08 (European Commission, 2005, pp. 28–35); Regulation No 1083/2006 of the European Social Fund (Council of the European Union, 2006a)), currently supported by new or updated funding and support measures (such as the renewed New Skills Agenda, the Erasmus+ program, up till now more than 20 running Sectoral Blueprints, CEDEFOP Skills Intelligence, and the Pact for Skills). The objectives in this respect are to develop skills to be 'fit for the future' and their implementation within education and training pathways and curricula, with the aim of addressing skill shortages and bottlenecks; better matching supply and demand, and anticipating emerging skill needs and gaps for European labour markets.

Having said this, the establishing European Skills Alliance for Industrial Symbiosis (SPIRE-SAIS) gives answers to the main challenges of Energy Intensive Industries (EIIs) and the relevance of Industrial Symbiosis and Energy Efficiency. Against this backdrop the SPIRE-SAIS approach, its objectives and methodology is outlined leading to final results, which have to be further implemented and developed after the project duration with the sustainable skills alliance under European Pact for Skills with the Large Scale Partnership Energy Intensive Industries (LSP EII). Background for Establishing a European Skills Alliance for Industrial Symbiosis (SPIRE-SAIS)

1.1 Background for Establishing a European Skills Alliance for Industrial Symbiosis (SPIRE-SAIS)

1.1.1 Industrial Symbiosis of Energy Intensive Industries

The Energy Intensive Industries (EIIs) (chemicals, cement, metals, water, etc.) contribute to around 15% of EU manufacturing added value. They produce an important share of European wealth and provide over 7 million jobs to European citizens. Against this background, these industries could become a game changer for the Green Deal by working more closely together with Industrial Symbiosis (IS) and related Energy Efficiency (EE).

Since 2009, Industrial Symbiosis has been incorporated into policy reports and recommendations across the Commission, in support of resource efficiency, climate change mitigation, eco-innovation and green growth. In 2018, a report commissioned by DG GROW estimated the economic benefit available to Europe through Industrial Symbiosis as up to €72.7 billion through cost savings from landfill diversion, and up to an additional €12.9 billion through transactions of secondary materials. In order to capture this economic benefit for EU industry, mainstream uptake of Industrial Symbiosis must be enabled.

The 2018 Amendment to the Waste Framework Directive (2008/98/EC) (European Parliament & Council of the European Union, 2008, 2018) passed into law calls for member states to promote sustainable use of resources and Industrial Symbiosis. According to the Call for Tender: European Network of Businesses and SMEs for Industrial Symbiosis, 2019 (DG GROW), "there is a significant exploitable industrial symbiosis potential in Europe […] Overall, industrial symbiosis is expected to grow significantly. Moving toward a low carbon industry and society implies that more industrial symbiosis solutions will be required and implemented. […] There is a lack of common standards or guidelines on the measurement and reporting of symbiotic

exchanges despite initiatives such as NISP or ELIPSE" (European Commission, 2018, pp. 5–7).

According to the CEN Workshop Agreement on Industrial Symbiosis, 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.

In the review of projects on Industrial Symbiosis of the European Commission (Sommer, 2020, p. 44) it is recommended:

- "To establish a community of practice offering guidelines for rolling out Industrial Symbiosis to more regions and more industries in Europe, which are often not aware how to take this forward.
- To use the concept of symbiosis readiness level to drive Industrial Symbiosis to full exploitation. This would focus on steps identifying what is needed in terms of technologies, business models, ecology (sustainability) and management in a company."

Symbiosis readiness level	Technology	Business	Ecology	Management
9	Commercialisation	Business case continuously controlled, reported and shared	Sustainability benefits proven	Resilient partnership
8	Extended operation	Finalise legal framework	Benefits routinely monitored and reported	Practical operation and management starts
7	Demonstration	Partners committed	Monitoring and reporting begins	Senior management is involved and supports industrial symbiosis case
6	Prototype demonstration 'looks like'	Business case with all details	Permits applied for	Concept for joint management is developed
5	Breadboard demonstration 'acts like'	Evaluate competitiveness	Sustainability assessment finalised	Partners start joint evaluation of industrial symbiosis. potential
4	Proof of concept validation	Check resources and criteria	Sustainability assessment in progress	Partners indicate interest
3	Proof of concept research (bench scale)	Check fit with strategies of partners	Thorough data collection	First contact with partners
2	Academic research	Develop concept	Rough estimate	Potential partners (*) identified
1	Initial ideas			

Figure 3. Proposal for defining the symbiosis readiness level

(*) Partners in this context means all stakeholders in the process of implementing industrial symbiosis, including e.g. the broader public, public authorities and industrial partners.

Figure 1: Symbiosis Readiness Levels (Sommer, 2020, p. 12)

Industrial Symbiosis enhances resilience by providing alternatives to the traditional supply chain: introducing diversity into the supply chain broadens the knowledge and resources available to a company. Alternative inputs decrease reliance on critical materials and increase the potential supply pool, thus mitigating risk of supply. When a new supply replaces a virgin material, a reduction in carbon emissions typically is the result. Industrial Symbiosis also fosters innovation as new industries, start-up companies and markets are developed that transform existing resources in the value chain into a usable form.

Workers in the process industries today are not trained in sustainable development, resource efficiency, Industrial Symbiosis, or circular economy thinking, and many will have experience deriving primarily from a single industry. Going outside their sector, and their traditional supply chain, is not usual for many companies: However, Industrial Symbiosis initiatives generally involve transactions between different industry sectors. The realisation of this concept usually faces a series of technological and non-technological challenges and barriers, such as among others:

- **Economic nature of the relationships:** For an Industrial Symbiosis initiative to be successful, it is absolutely necessary that the material/energy exchange makes economic sense for all the organizations involved. Economic studies must be conducted and bilateral contracts regarding the characteristics of the flows exchange, including amounts and price, need to be signed between the participant industries prior to undertake any action.
  The materials/energy flows bought from one industry to another usually substitutes primary sources of those flows. It is advisable, however, that the buying industry keeps alternative sources for those flows, particularly at the beginning of the IS relationship, in case the supply is unexpectedly interrupted, thus minimizing risks. This is particularly important when the product exchanged is crucial for the buying company.
- **Investments and funding**: Industrial Symbiosis initiatives often involve large investments in infrastructure to transport the products exchanged or adapting the technological process of the industries involved (collection, purification, etc.). Different financial situation of the companies involved in an IS initiative may hinder the funding of this infrastructure. Public resources to co-fund this type of investments, notably from the corresponding municipality, are the most common option. Public involvement is very common in these long-term cost saving investments, in which the positive returns materialize over a long-time frame. In other cases, the industries own or have access to existing infrastructure, such as the natural gas grid, that can be used to transport the products exchanged.
  The participation of facilitators can foster the identification and assessment of new IS possibilities among different industries. However, the costs incurred by the facilitator need to be covered.
- **Policies and legislation:** When a process is ready to be changed to a symbiosis exchange, it often happens that regulations pose an important challenge to its feasibility. The ideal solution is to try to involve regulatory authorities as partners in the projects, which makes it possible to account for the correct regulations along the way and propose permits for reuse options when projects produce environmental benefits. To this end, local companies should also collaborate in the search and development of rules and regulations relevant for the implementation of this vision with the politicians and public authorities.
- **Trust and communication:** Good communication and trust among the participant organizations in an IS initiative is of paramount importance. This may already exist before

the organizations start such an initiative, particularly if they are located close to each other and are organized around a cluster or another similar entity.
Building up trust relationships when these did not exist before might be eased by the participation of an independent organization – a facilitator – without economic/industrial interests in which the industries trust. This role is normally played by a research organization/university or a public entity. The facilitator is normally in charge of analysing the data provided by the industries and assessing the technical, economical and/or environmental feasibility of the possible exchanges. Moreover, it may also organize workshops and activities to build a good relationship between the industries that are to implement IS initiatives. Also, it helps in the planning of the actions and facilitates their implementation.
Conducting IS initiatives is obviously much easier when there is no direct competition between the industries involved, although examples of competing companies in the global market exist. Finally, it is also important that decision-makers of the participant industries are involved. Very often, participants in IS initiatives are part of multinational companies and decisions are not made in the place where the IS concept takes place, which may complicate the communications among the participants and result in frustration and ultimately in the initiative being cancelled.

Furthermore, as mentioned above, it is important for the companies that all the synergies are economically profitable. To support the economic impact, political regulation can reward emission deductions or penalize waste disposal.

As a result, stakeholders representing **EIIs and circular economy actors** strongly argue that an intervention **at EU level on skills** to **enable and accelerate take-up of IS and Energy Efficiency** is paramount to address the possible skills shortages in the sector while empowering EU citizens with the necessary set of tools for future job profiles.

1.1.2 Relevance of Skills for Industrial Symbiosis

Resource and Energy Efficiency demand, as well as economic, digital and technological developments, are a challenge for the EIIs which need to be competitive and at the same time respectful of European guidelines towards increasing sustainability. The necessity arises for updated qualifications, knowledge and skills supporting cross-sectoral collaboration and IS activities. The evolution of high-tech production processes combined to Energy Efficiency and the circular economy targets demand for continuously updated skilled workforces in order to enforce competitiveness and improve cross-sectoral symbiotic practices, along with the new working practices and organisation that are subsequently adopted. The ongoing digital transformation of all the processes (Industry 4.0) represents a strong enabler in this direction: restructuring and digital optimisation of all the processes increase the demands for a highly qualified, specialised and multi-skilled workforce as well as for an overall multi-disciplinary approach to work tasks. Skills shortages, recruitment difficulties and talent management are other challenges the EIIs are facing. However, technologies alone will not solve the economic and ecological challenges. Therefore, having a look at the Industry 5.0 concept (Breque et al., 2021; Dixson-Declève et al., 2022) is of interest, putting human-centricity on top of technological and organizational changes, respecting the boundaries of the planet (sustainability) and ensuring supply chains (resilience).

In effects, in the EU society a general lack of information is observed on the technological systems as well as in the scientific and technical challenges that EIIs are facing in the practical

implementation of IS. This aspect reflects in a scarce attractiveness of such type of industry, especially on new generations. SPIRE-SAIS aims at reversing this trend by developing suitable formation and training paths, which allow young talents to be engaged and to cooperate with expert personnel in the development of a cross-sectorial collaboration toward sustainability improvement enforcing energy and resource efficiency.

Adding new strength and inventive capacity to this new workforce, Industrial Symbiosis can in this case act as a tool, thus triggering the symbiosis of intergenerational skills that can certainly be fundamental in managing the complexity of this intersectoral exchange.

One of the major challenges to its widespread adoption is the need to approach resource use holistically and understand how to approach a cross-sector opportunity. These issues are not insurmountable: consortium partner ISL has been enabling Industrial Symbiosis implementation through training and technical support around the world since 2006, with the impact of engaging over 20,000 businesses in over 30 countries in Industrial Symbiosis. By formal training, it is hoped that this type of thinking can penetrate industry much more quickly and bring about the above benefits to a wider range of companies and communities.

There are of course many training courses available for company employees in the fields of waste management, Energy Efficiency, logistics, process optimization, etc.; however, what most of these courses have in common is the focus on the company looking internally at its activities and acting in isolation. Very little applied work has been undertaken for companies working in collaboration across a range of business resource efficiency issues. Similarly, courses associated with industrial ecology (an emerging field which seeks to remodel linear industrial systems so that they more closely resemble the more efficient, ‘closed-loop’ workings of biological ecosystems) are typically confined to academia.

Therefore, SPIRE-SAIS supports the mainstream adoption of good practice approaches proven through implementation by advancing the mutual understanding of actors (public, private, third sector, and community) and help the above actors consider and implement Industrial Symbiosis.

1.1.3 Achieving EU Policies

As a goal for supporting a globally competitive and sustainable industry the European Commission has invested significantly in innovation and technological development and in this way created the foundations for investment in people. However, an important part of skills development is looking for employability and transferability of skills as and additional element of the Twin Transition. By identifying opportunities to develop new skills and improve employability aligned with the future needs of the industry, work in the sector will be improved. However, the integration of new skills demands within national VET (and degree) programmes from which the industry draws its recruits, provides the foundations for sustainable workforce recruitment, development and retention (i.e. management of talents).

Early identification and anticipation of skill needs are important for the timely development of appropriate training policies and programmes. There is, for example, a likely time-lag between what is happening at a sector level (e.g. technological innovations) and the skill requirements that subsequently emerge and require seamless integration within education and training programmes. The time-lag often differs according to member-state institutional, legal and regulatory contexts. In particular, as far as EIIs are concerned, the impacts of globalisation, ageing labour force and productivity gaps bring further pressure to forecast future skills needs in effective ways, including the need to develop transferable skills that address issues of sector

restructuring and job losses (e.g. entrepreneurial competences, which are crucial in enabling people to adapt to change and seize new opportunities).

Therefore, this SPIRE-SAIS fits directly with the objectives of participating organisations and provides a framework to consolidate previous sector efforts aimed at addressing current, emerging and future skill needs. For example, the results of the first phase of establishing a sector council on jobs and skills (a European Sectoral Skills Council, ESSC), which was aimed at identifying critical actors existing at national level (i.e. national structures, including social partners, education and training representatives, as well as public authorities on national/regional level that analyse labour market and skills development in process industry), provides the groundwork for identifying members of the skills alliance consortium and Blueprint strategy.

However, companies expressed concern that existing initiatives especially dealing with cross-sectorial cooperation for IS implementation require consolidation under the umbrella of a sector wide strategy (such as the ERASMUS+ sectoral blueprints, namely the ESSA project related to the steel sector as part of the SPIRE sectors), which draws together in comprehensive ways current approaches to tackle serious skills challenges. Hence, the Blueprint strategy brings together a wide range of stakeholders of the EIIs to continue collaborating on the anticipation of skills (for jobs), developing relevant tools and on organising the exchange of information and best practice. Close cooperation between EIIs, stakeholders, VET providers and sector associations will contribute to enhanced skills intelligence, monitoring and forecasting of skills needs, promoting a multi-disciplinary approach that is fundamental for IS, understanding skills mismatches and improving dialogue between education and the labour market. The whole project partnership is committed to delivering the necessary skills to industry and investing in the workers' employability. SPIRE-SAIS is strongly supported by the process industry platform A.SPIRE[1] and Processes4Planet and sector associations (ESTEP, IMA, EA, WE, ECEG, EIT Raw Materials, Cerame-Unie, CEFIC, CEMBUREAU) to provide the permanent cross-sectoral basis for setting skills agendas and developing the right skills policies in close cooperation with EU policymakers.

Upskilling on Industrial Symbiosis contributes to the following European policies supporting wider delivery of Industrial Symbiosis:

- European Waste Framework Directive (2009)
- Roadmap to Resource Efficient Europe – exemplar (2011)
- DG Regions: Connecting Smart and Sustainable Growth through Smart Specialisation – exemplar (2012)
- DG Enterprise: Communique on Green Entrepreneurship (2013)
- European Resource Efficiency Platform – short-term recommendation (2014)
- DG Innovation & Research: Short guide to assessing environmental impacts of research and innovation policy (2014)
- Circular Economy Package (2015)
- European Environment Agency, Circular economy in Europe (2016)
- European Circular Economy Stakeholder Platform (2017)
- DG Energy Strategic Energy Technology Plan (2018)

[1] A.SPIRE is the European Association which is committed to manage and implement the Processes4Planet co-programmed Partnership. It represents innovative process industries, 20% of the total European manufacturing sector in employment and turnover, and more than 170 industrial and research process stakeholders from over a dozen countries spread throughout Europe. A.SPIRE brings together cement, ceramics, chemicals, engineering, minerals and ores, non-ferrous metals, pulp and paper, refining, steel and water sectors, several being world-leading sectors operating from Europe.

- The amendment to the Waste Framework Directive that requires member states to "promote sustainable use of resources and Industrial Symbiosis" (2018)
- EU4Environment (2019)
- European Green Deal (2019)
- CORALIS project (2020)
- Circular Economy Action Plan (2020)
- Flagship Initiative for a resource-efficient Europe under the Europe 2020 Strategy (2020)
- European industrial strategy (2021)
- Regulation on Eco-design for Sustainable Products (2022)
- EU Strategy for sustainable and circular textiles (2022)
- Revision of the Construction Products Regulation (2022)
- Eco-design and Energy Labelling Working Plan 2022-2024 (2022)
- Directive on Energy Efficiency (2023)
- Critical Raw Materials Act 2023
- Transition Pathway for Metals 2023
- Net-Zero Industry Act 2023, incl. e.g. Net-Zero Roadmap Cement 2024 https://cembureau.eu/media/ulxj5lyh/cembureau-net-zero-roadmap.pdf

Furthermore, the energy intensive industry sectors are at the heart of the material circularity concept. The European Commission Circular Economy Package is the main policy initiative to drive society towards a waste-to-a-resource thinking through reuse, recycling and recovery. Since its launch, the European Commission has been examining options and actions for a more coherent policy and regulatory framework in this direction. The Circular Economy Communication COM/2015/0614 lacks an implementation plan with clear priorities (European Commission, 2015). However, it has led directly to amendments to the Waste Framework Directive, the Packaging Waste Directive, Landfilling Directive, and the Directives on end-of-life vehicles, on batteries and accumulators and waste batteries and accumulators, and on waste electrical and electronic equipment. In particular, the European Commission has proposed actions to support the circular economy in each step of the value chain – from production to consumption, repair and remanufacturing, waste management, and secondary raw materials that are fed back into the economy. However, the investments in waste management must have a payback and current market signals appear insufficient to boost the circular economy.

In order to improve this, amongst others, the following issues will have to be considered:

- The waste legislation focuses, in many cases, on quantities (weight-based collection or recycling targets) and less so on the quality of recycled materials;
- Closed-loop recycling, although in many cases technically feasible, is not always the most sustainable and/or economical solution, e.g. due to the energy intensity of processing;
- Movement of waste across borders;
- Access to sorted waste material;
- Cost reduction of recycling, and technical performance of recycled products;
- The proposed Circular Economy Monitoring Framework does not address durability. A new indicator needs to be developed to measure this feature.

Among other challenges all the above pose, the following two elements are critical:

- Definition of Waste and lack of harmonized EU regulation: Inconsistencies between existing regulations, e.g. related to REACH or the end-of-waste criteria, underpin the use of certain potential secondary materials. Moreover, classifying some valuable materials as waste creates hurdles to circularity.
- Innovation as a trigger for Circular Economy implementation: There is a drive towards the circular economy and low carbon economy, but legislation is not totally fit for the implementation of innovative solutions. This is a hurdle that risks delaying market deployment of innovative technologies, materials, and processes. In parallel, regulations should also touch upon how the market embraces new circularity solutions. To this end, technological development and legislation must go hand in hand. A holistic legislative approach is necessary to cover all stages of technology developments.

Among other actions, it is necessary to move towards a full product life cycle definition of circularity and focus on the interfaces between different steps of the value chain (extraction/production, production/production internal loops, production/use, collection, waste-management/recycling/ production).

On the other hand, it is clear that in view of the large number of regulations, the role of associations is instrumental, and so is the coordination between different stakeholders from different sectors. It is strongly encouraged to set up round tables in which authorities, technology providers and final users meet so as to shape the regulatory legal texts to the industrial reality.

1.1.4 Main European References and Alignments: Sectoral Blueprints, Pact for Skills, Industry 5.0, P4Planet

Against this backdrop, the development of the European Skills Alliance for Industrial Symbiosis (SPIRE-SAIS) was initiated by the “New Skills Agenda” and the related program for Sectoral Blueprints on Skills launched by the European Commission and funded by ERASMUS+. The purpose of these already more than 30 Blueprints (see Figure 2) is to:

- “Gather skills intelligence and feed this into CEDEFOP's Skills Intelligence tool
- Develop a sector skills strategy
- Design concrete education & training solutions for quick take-up at regional and local level, and for new occupations that are emerging
- Set up a long-term action plan
- Make use of EU tools e.g. EQF, ESCO, Europass, EQAVET
- Address skills shortages and unemployment”.

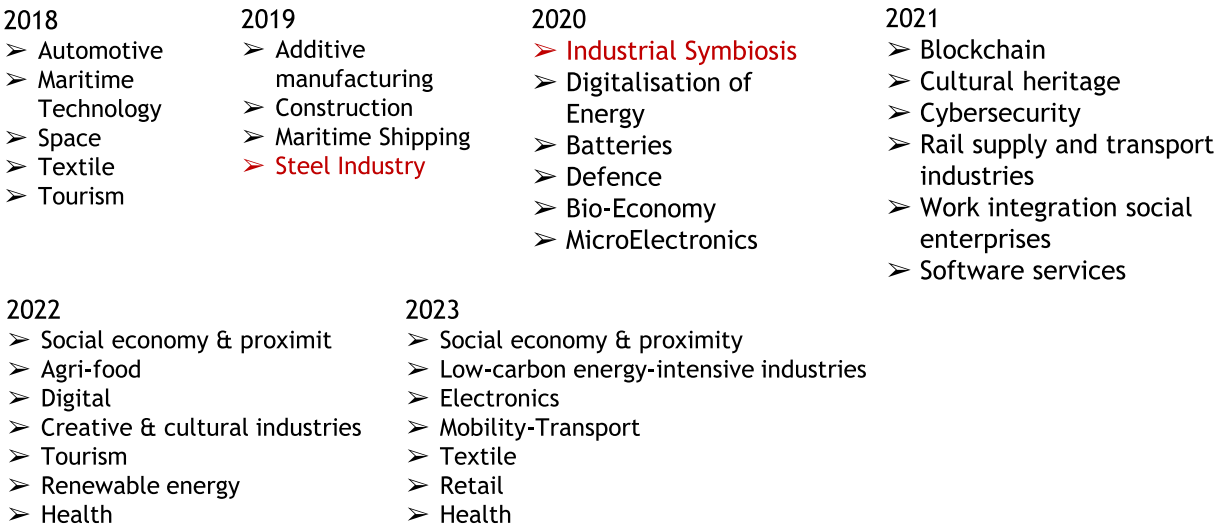


Figure 2: European Sectoral Blueprints (2018-2023). Source: European Commission, n.d. b

The Sectoral Blueprints and therefore also SPIRE-SAIS are flanked by other European initiatives, namely the Pact for Skills. This sector overarching "engagement model for skills development in Europe" has already been signed by SPIRE-SAIS 2022, approved by the Commission, and led by its further development to the Large Scale Partnership Energy Intensive Industries (LSP EII). With this LSP EII we integrate the two Blueprints and Alliances SPIRE-SAIS and ESSA consortium aiming at integrating further "companies, workers, national, regional and local authorities, social partners, cross-industry and sectoral organisations, education and training providers, chambers of commerce and employment services" in a concerted action.

In a broader industry perspective SPIRE-SAIS is also dedicated to the new "Industry5.0" discussion launched by the European Commission, setting the focus on a sustainable, human-centric and resilient European industry. In its related Discussion Paper (Breque et al., 2021) SPIRE-SAIS is part of the list of projects already in line with the Industry 5.0 concept, addressing the context of "the human and societal aspects of the digitalisation of our (industrial) workplaces, hence contributing to the human-centric perspective of Industry 5.0" (Breque et al., 2021, p. 12) and explicitly named as a good example of combining technological and training development (Breque et al., 2021, p. 19).

Not at least against this backdrop, SPIRE-SAIS is strongly involved in the program "Processes4Planet". As the SPIRE-SAIS partners are deeply integrated in the A.SPIRE community and the program "Processes4Planet" we are actively stressing the relevance of skills, explicitly related to technological innovations. In its Strategic Research and Innovation Agenda (A.SPIRE, 2021b) skills are part of non-technological issues for improving technology development and competitiveness (esp. through human resources and skills); a specific innovation program for Human Resources underlines this relevance (A.SPIRE, 2021a; chapters 4.15 and A14b). The update of the Strategic Research Agenda (A.SPIRE, 2024) stresses explicitly the human-centricity aspect and the need to operationalise this pillar for the process industry.

Via SPIRE-SAIS partners we also work closely with the Hubs for Circularity innovation program and the Permanent Working Group "Societal Innovation" within the governance structure of the "Advisory and Programming Group" as well as with the European Community of Practice of Industrial-Urban Symbiosis.

Furthermore, SPIRE-SAIS (together with ESSA) was engaged in integrating the skills perspective (as part of Non-technological Innovation) within the new SET Plan Action 6 programme (Shtjefni et al., 2021, p. 35).

Beside this SPIRE-SAIS is intensively cooperating with other Sectoral Blueprints (such as ESSA, DRIVES, ALLBATTS, Skillman, Green Skills for Hydrogen), Industrial Symbiosis and Energy Efficiency related programmes (such as Processes4Planet, Clean Steel Partnership, European Junior Water Program), projects (such as INSIGHT, BIMprove, SUSTAIN), and civil society initiatives (such as Circular Economy and its Circular Jobs Initiative, Carbon Market Watch).

1.2 SPIRE-SAIS Approach

The challenges faced by European Energy Intensive Industries (EIIs) (chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**) show the necessity for identification and anticipation of skill needs for the continued competitiveness of the European Industry. The Blueprint for the **industry driven long-term skills strategy***,* as the principal outcome, facilitates companies and VET institutions efforts to transition the workforce and meet future needs in relation to, for example, the deployment and implementation of new technologies, the material and environmental optimisation of the production process, Energy Efficiency improvements, high-performance materials development, and so on. In meeting the emerging demands of the industry, the basis for highly skilled employment is established and the foundations for attracting and retaining talented people to the energy intensive industries laid down, thus keeping jobs in Europe and fostering smart, inclusive and sustainable growth.

Nowadays we are starting to observe the first European examples of Industrial Symbiosis platforms, born to promote the sharing of residues and resources, in the widest sense of the term. These platforms are realised through the creation of networks of companies operating in different sectors, and through the creation of projects, solutions and integrated approaches. The effects of a transition to a circular economy and the use of sustainable business models, which make the management of resources on the territory more and more efficient, are increasingly evident, extending the interest also to the conservation of the techno sphere and the biosphere.

Initiatives of this kind usually rely on research centres and external consultancies. Therefore, these initiatives appear for specific occasional needs and urgencies, rather than arising from a strategic and systematic approach, intrinsic to the industrial reality.

The significant change that takes place with this project, is to create internal skills, able to fully understand all the complexities of industrial production processes (within the own company, but also across companies and sectors, value chains). At the same time these competences have to be able to grasp, in an integral way, all the opportunities for interacting with the homologue, counterpart of the companies with which they want to realize the symbiosis. Going farther, circular economy, Industrial Symbiosis and Energy Efficiency have to be based on cross-sectoral knowledge to unfold their whole potential.

Therefore, people and their skills and qualifications are key. The cross-sectoral Skills Alliance of EIIs within the A.SPIRE community is an excellent ground to work in an interrelated and co-creative way, guaranteeing the integration of different perspectives of the sectors on the subject and ensuring the sustainability of the skills strategy by their direct involvement in the innovation process. Setting up the development of the Blueprint as a **cross-industry driven social innovation** process means that technological, organisational and social aspects and impacts

were considered right from the beginning of the process in parallel, in an interrelated way. It means also that workers, trainees and responsible managers of the companies were included in the development process, integrating their knowhow and ensuring their view on both demands and solutions.

Key components of SPIRE-SAIS are:

- Build on existing A.SPIRE coordination, projects and activities (for Industrial Symbiosis and Energy Efficiency)
- Putting the sectoral Blueprint perspective further to a cross-sectoral approach, covering all the A.SPIRE energy intensive industry sectors
- Embedding sector associations as central communication and dissemination intersection (and feedback, quality ensuring entities)
- Stocktaking of the extensive experience and competence of the partners evident in the huge list of Industrial Symbiosis, Energy Efficiency and related VET projects.

The constant adjustment of needed skills is necessary for the competitiveness of the EU Process Industry. The *industry driven long-term skills strategy* of SPIRE-SAIS allows VET institutions to adjust their training programmes and companies to change their workforce mind-set, in order to promote deployment and implementation of new technologies aimed at optimisation of production processes, Energy Efficiency through IS and construction of high-performance materials. This target comprise attracting and retaining talented people, promoting cultural exchange among generations of workers, keeping jobs in EU and fostering smart, inclusive and sustainable growth.

Educational institutions at any level, VET providers and national associations, will need to cooperate, also considering national regulations, to the final aim of giving rise to a strong technical and cultural European backbone of IS, which will ensure a secure, continuous and long-lasting evolution of the production systems in the desired direction. This background is of high relevance for the skills development in the energy intensive sectors. Hence, this project contributes to achieving EU objectives in skills identification and anticipation within the energy intensive sectors in direct and immediate ways. The Blueprint of the new skills agenda and strategy was set-up within a **social innovation process**, combining technological development and social impact by integrating the relevant stakeholder groups and beneficiaries in a co-creation process (see objectives of SPIRE-SAIS in the following chapter 1.2.2)

SPIRE-SAIS contributes to developing a cross-sectoral skills strategy in relation to the ‘New Skills Agenda’, which calls for investment in a broad array of economic sectors and the Erasmus+ approach on Sectoral Blueprints for different sectors (see Figure 2).

The SPIRE-SAIS approach to develop the Blueprint was based on a sequential and cyclic work program. Beside Management and Quality Assurance (WP 1) and Monitoring and Evaluation (WP8) SPIRE-SAIS was working in an iterative way. Starting with exploring the main current and future Technological and Economic Development (WP2), SPIRE-SAIS provided a reliable cross-sector view for the subsequent work packages on industry skills requirements (WP3) and VET system context and support (WP4). These work packages fed into the Blueprint development (WP5) transferred and implemented in the different sectors (WP6). On the background of these work packages (mainly the blueprint and its implementation) policy recommendations were elaborated and dissemination activities are conducted (WP7) (see Figure 3below with the related main questions and activities).

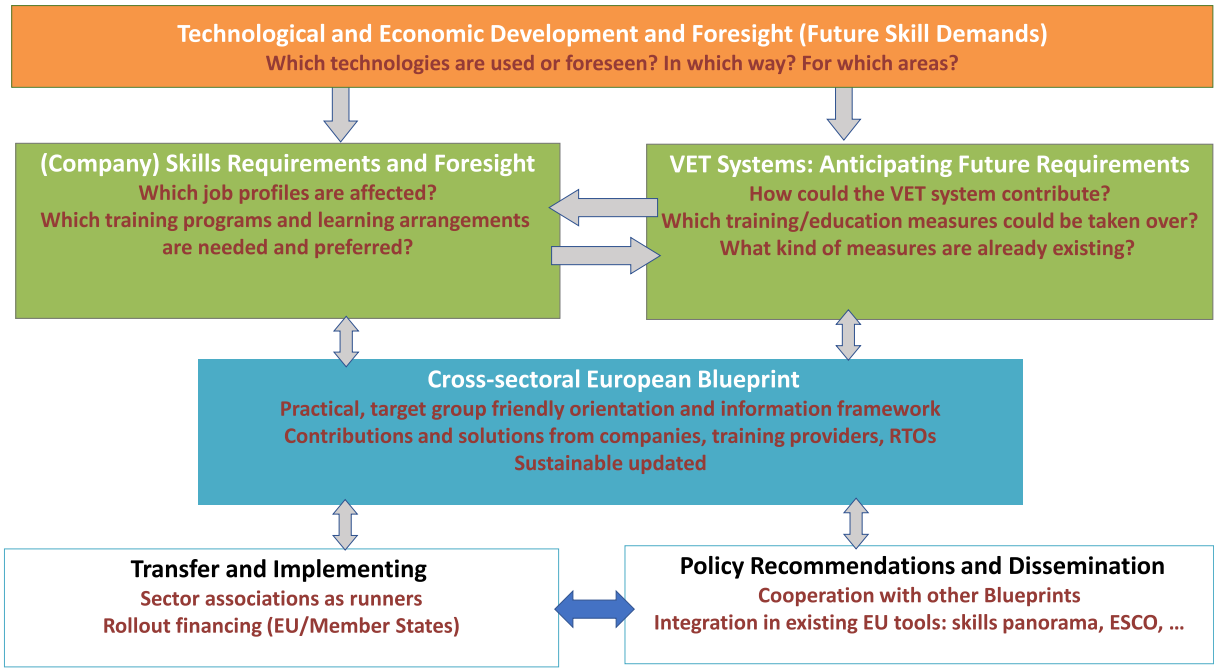


Figure 3: SPIRE-SAIS Methodological Approach

By bringing together information from partners and governing body members, together with market information and technological development strands, this approach and work program:

- ensured a constant view on changing IS and EE skills needs in the different sectors, linked to the main drivers (emerging technologies and trends) that are influencing the change.
- aggregated and continuously updated sectoral knowledge and skills intelligence at European level, thus defining and continuously updating the Blueprint strategy for skills in the energy efficient sectors.
- provided direction for the Blueprint development and its transfer and implementation as well as for policy recommendation and dissemination - ensuring that future skills needs are met.

Within a comprehensive social innovation process, development and implementation affords a cyclical iteration of research, solutions and strategies. Therefore, two rounds of Blueprint development were foreseen, leading to five phases of the project:

- **Phase 1:** Identifying skills requirements and basics for establishing the Blueprint, first contours of the Blueprint
- **Phase 2:** Reflecting the first research results and network development with policy, social partner, European and national representatives
- **Phase 3:** Implementing a prototype of the European skills agenda and strategy / upgrading the results of phase 1
- **Phase 4:** Reflecting the upgraded research results and networks approach as well as the comprehensive European skills strategy in a first implementation and transfer phase with policy, social partners, European and national representatives, setting the ground for the future sustainable strategy
- **Phase 5:** Optimisation and finalisation of a concerted European Blueprint in line with national skills agendas for anticipating skills demands and fostering smart, inclusive and sustainable growth.

In parallel to these phases European, sectoral and national events have been and will be used strategically, to consider the different perspectives of the sectors and VET systems of the involved Member States, emphasizing a strong focus on exploitation and sustainability of the Skills for Industrial Symbiosis Blueprint right from the beginning of the project. Thereby, one step to sustainability was to place the SPIRE-SAIS homepage as part of the A.SPIRE website www.spire2050.eu/sais.

Against this backdrop, the *industry driven pro-active skills strategy* of the Blueprint is focusing on:

- Identifying and promoting successful sectoral upskilling schemes, including the exchange of existing tools and best practice (e.g. on European and national occupational standards), as well as the efficient management of knowledge on skills and qualifications for the sector.
- Developing training activities and modules, including for leadership, training the trainers, to be integrated into VET provision at European, national and sector level.
- Strategising on improving the attractiveness of the Industry and 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.
- Strategising for the implementation of measures to meet defined skill needs.
- Implementing the Skills Alliance by strategising for political support measures and the means for mobilising and integrating stakeholders and policy makers of the EU and national level to meet Blueprint aims and objectives.

Building on the described activities implementation and transfer of the Blueprint was done in a collaborative way at European, sector and Member State level, incorporating associations, VET system institutions, national rollout preparation, collaboration with other blueprint developing sectors. Key Performance Indicators (KPIs) monitor success and adjust needs continuously in respect of implementation of Blueprint goals and to adjust the agenda and strategy in time to upcoming new developments and environments.

Finally, policy recommendations were developed related to the main challenges identified:

- Definition of policy recommendations, individuation and analysis of the main issues to be covered
- Planning and conducting dissemination actions to make the defined policy recommendations effective
- Actively identify, implement, promote and secure political support measures for mobilising and integrating stakeholders and policy makers of the EU and national level.

1.2.1 Programmatic Orientation and Blueprint Outline

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

already in the technological innovation development phase - leading to more responsibility for and increased supervision of the production process, advanced "collaboration" between humans and robots." "Rather than asking the industry worker to adapt his or her skills to the needs of rapidly evolving technology, we want to use technology to adapt the production process to the needs of the worker, for example to guide and train him/her." (Breque et al., 2021, p. 14)

Against this backdrop, skills are seen as 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 focusing on a *cross-sectoral perspective of new or updated skills for Industrial Symbiosis and Energy Efficiency* by combining demand with supply and coordination of skills adjustment:

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 with special attention to the interfaces between these pillars (see Figure 4).

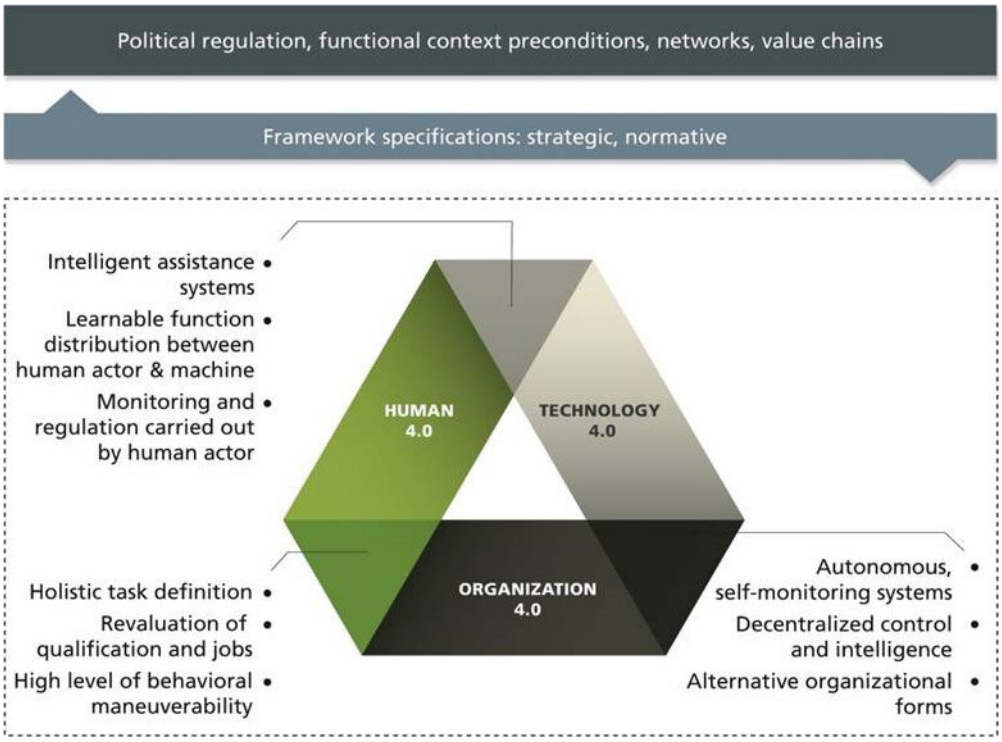


Figure 4: Triangle Technology – Organisation – Human (Dregger et al., 2016, p. 2)

System interfaces are central for creating scope for innovative digital and green work, adjusting and matching **technology, organization and human resources.** Not the optimization of sub systems but the complete system with interfaces linking the three pillars have to be considered (Dregger et al., 2016):

- **Human – Organization** (holistic view and flexibility): new options because of optimized information in real time (integration of conception and execution, holistic working design, flexibility and decision making, situated learning on the job, polyvalent human-

resource allocation), flexible working structures on the basis of higher qualifications, collaboration of specialized workers, support of interdisciplinary collective intelligence

- **Technology** – **Human** (adaptive and complementary interaction): hybrid interaction, complementary division of work between machine and human, human – machine dynamic collaboration
- **Organization – Technology** (decentralization and bottom-up processes): opening and blurring of boundaries of well-established and accepted company structures - decentral control loops, complementary self-monitoring, automatic control in the frame of confined organization segments, integration of functions in real time (apart from former sequential and differentiated processes), decentralization and delayering, sustainable change of management and line functions

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 taken up as early as possible by pre-VET education (Kindergarten, primary and secondary schools) (see Figure 5).

To ensure sustainability of SPIRE-SAIS and the integration of the different sector perspectives, the process of developing and implementing the Blueprint was and 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).

The common development of the Blueprint Strategy and Alliance with such a huge consortium is desirable but not easy to handle. Different perspectives, interests and inputs of the involved stakeholder groups have to be aligned and harmonised; new measures and tools to be developed; European, national, and regional levels to be considered (including different working cultures, VET systems, legal frameworks, etc.) and incorporated; and others. Therefore, SPIRE-SAIS is composed as a *social innovation process combining technological and social innovation* (Howaldt, 2019; Kohlgrüber & Schröder, 2019; Kohlgrüber et al., 2019) ensuring to work in synergy, providing an overarching account of industry developments and skill needs for integration within European and national VET frameworks. Setting up the development of the Blueprint as an industry driven social innovation process means that technological, organisational and social aspects and impacts were considered right from the beginning of the process in an interrelated way. It also means that the workers, trainees and responsible managers of the companies were included in the development process, integrating their know-how and ensuring their view on both demands and solutions. Within such a social innovation process, a constant view on the changing skills needs in the energy intensive industry sectors, linked to the main drivers (emerging technologies and trends) of change, aggregating and continuously updating sectoral knowledge and skills intelligence at European level, thus defining and continuously updating a Blueprint strategy for skills in the sector is guaranteed beyond the project life span.

Figure 5: Demand and Supply Side

The social innovation process is a mutual learning process, discussing different perspectives and leading to a common strategy to establish new social practices solving the skills adjustments of the industry better than the existing ones. This process does not stop at the end of the project, it rather sets the ground for a continuous improvement process embedding technological innovations and their impact on the skills needs of the workforce leading to a proactive adjustment process.

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 European Skills Agenda and Alliance on Industrial Symbiosis and Energy Efficiency with interested stakeholders from companies, research, training providers, social partners (industry 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** were planned and considered, ensuring an upgrading of the interventions and implementation of the Blueprint (see Figure 6).

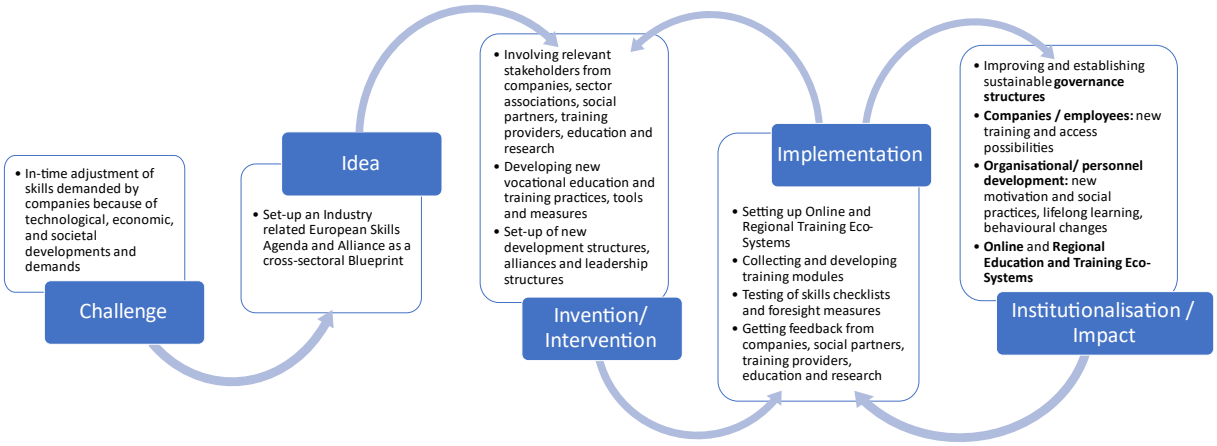


Figure 6: Blueprint Development and Implementation as a Social Innovation Process

To monitor this process and consider appearing modification SPIRE-SAIS defined process-oriented Key Performance Indicators (KPI) (such as stakeholders' involvement and endorsement of the Blueprint). Feedback loops helped and will help to adjust our ideas, objectives, intervention, implementation strategies and the institutionalisation procedures and structures as well as the impact.

1.2.2 Objectives and Impact

The main objective of SPIRE-SAIS is to develop an industry driven and pro-active skills strategy focusing on Industrial Symbiosis and Energy Efficiency across the different sectors of SPIRE (chemicals, steel, engineering, non-ferrous metals, minerals, water, cement, ceramics). This was piloted by the development of modules and tools for awareness as well as new skills for a practical implementation of IS solutions in a globally competitive industry, in order to anticipate new skills demands and to allow pro-active practical activities meeting the future requirements of the EIIs.

In line with the European New Skills Agenda, the Pact for Skills and the series of Sectoral Blueprints the main objective of the project was 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 ten sectors of the public-private partnership A.SPIRE (Sustainable Process Industry through Resource and Energy Efficiency): Steel, Chemicals, Minerals, Non-ferrous Metals (Aluminium), Water, Engineering, Ceramics, and Cement - during the course of the project completed by two new 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 (see Annex), 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. 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 representa-

tives 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.

In anticipating and identifying skill needs, the project identified industry job roles, with a profile of industry occupations described. Job roles as pertaining to occupations and categorised according to European skills definition norms informed the job profiles and skill classification database (D3.1; Carballedo et al., 2024). The database was the basis for the development of the matrix, a comprehensive framework designed to link job profiles, occupations, and national qualifications in three pilot countries (Germany, Portugal and Italy) in the SPIRE-SAIS project. It ensures that industry skills need, particularly related to Industrial Symbiosis (IS) and Energy Efficiency (EE), are adequately addressed by VET programs, integrated with EU classifications (e.g. ISCO, ISCED), frameworks (e.g. ECVET, ESCO, EQF, EQAVET, Europass) and standards associations (e.g. ECQA) to classify and inform understandings of job roles and skill content. The matrix helps to correspond job profiles with relevant qualifications and assesses how well current VET programs meet industry skill demands. It also aids in the integration of EU occupational and qualification frameworks into national systems, facilitating employee mobility and improving skills development. The digitalisation of the Cross-Sectoral Skills-Set Matrix on the SKILLS4PLANET platform allows stakeholders, employees, students, VET institutions, and others interested, to search the EII's skills needs and how to fill these gaps in the different countries (D4.3; Visionary Analytics, 2024a).

Within a co-creation process of the involved stakeholders SPIRE-SAIS:

- combines a European, cross-border sectoral approach with national/regional specifications by including national and regional system requirements - thereby reflecting different national conditions and VET frameworks and ensuring interconnectedness with the European labour markets;
- sets up a foresight scheme to identify current and future demands and requirements in a pro-active way, driven and run by the industry;
- comprises the cooperation of companies, education and training providers supported by research institutes and the involvement of the social partners to anticipate skill needs and develop appropriate content;
- develops concrete tools and activities together with the people concerned (such as HR managers, technicians and engineers, workers, trainers and teachers); a high number of workers of involved companies participated directly via internal workshops to integrate their perspectives right from the beginning of the project;
- fosters an interrelated and joint development of Industry 4.0 and Work 4.0 specific to the industry;
- ensures a cross-sectoral development and exchange of industry representatives, companies, policy, science and education.

In achieving these objectives, the project adopts a **Blueprint for an industry driven long-term skills strategy** for companies and VET institutions that:

- Recommends proactive skills adjustments to the workforce in response to the deployment and implementation of new technologies aimed at optimisation of the production process;
- Monitors and shortens the implementation of industry relevant qualifications in national VET systems, continuously;

- Develops and exchanges modules, tools and the experiences with the implementation process of the new skills agenda and strategy;
- Develops a blueprint that are discussed and compared with the solutions/blueprints of other sectors.

The project partnership in its entirety is concerned to deliver the necessary skills to industry and invest in the employability of its workers. Close cooperation between industry stakeholders will contribute to enhanced **skills intelligence**: the monitoring and forecasting of skills needs, understanding skills mismatches and improving dialogue between education and the labour market. SPIRE-SAIS is strongly supported as the appropriate platform to provide the permanent basis for setting skills agendas and developing the right skills policies in close cooperation with European associations and policymakers. Doing this, an ongoing platform and sustainable innovation process is perceived, run by the industry, taking up future challenges and improving the Blueprint continuously - affording a cyclical iteration of research, solutions and strategies, which reflect European objectives in the field of skills identification and anticipation (see social innovation process description above and Figure 6).

Hence, we established an *industry driven pro-active skills strategy* or Blueprint that is able to:

- Identify in proactive, rather than reactive, ways the skill needs and demands of the industry in the light of a cross-sectorial approach to sustainable growth, taking into account skills gaps and shortages, and forecasts of supply and demand;
- Identify training and curricula requirements, including ways to implement new vocational education content and multi-disciplinary approaches to tackle the IS and Energy Efficiency targets in immediate and effective ways, within both companies and education and training institutions;
- Improve and update training short-termed and with higher quality by new programs for train the trainer (key element of the new skills agenda)
- Identify, implement and secure necessary political support measures by mobilising and integrating stakeholders and policy makers of the EU and national level;
- Identify and promote successful sectoral upskilling schemes (incl. exchange of existing tools, best/good practice exchange, knowledge) and efficient management of knowledge;
- Improve the attractiveness of the process industry and 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;
- Identify Key Performance Indicators (KPIs) to monitor success and adjustment needs continuously in respect of these goals and to adjust the agenda and strategy in time to upcoming new developments and environments.

SPIRE-SAIS utilises existing European tools like ESCO, EQF, Europass, ECTS, EQAVET and ECQA (in addition to international classifications, such as ISCED and ISCO) for job profiles and skills content assessment to fed company skills demands for specific job profiles in line with existing occupation databases. Therefore, SPIRE-SAIS connects the skills classification, assessment and foresight as much as possible with relevant ESCO occupations and certification and acknowledgement tools (such as Micro-credentials, ECQA, ECVET).

In addition, relevant national and regional VET programmes were addressed especially in the rollout activities. Understanding of national programmes and standards is imperative for improved worker mobilisation but also for a more consolidated approach to tackling skill needs in immediate ways.

General Impact

The challenges faced by European energy intensive sectors, as detailed in the sections above, asks for the identification and anticipation of skill needs for competitiveness of the European Industry. The Blueprint for the industry driven long-term skills strategy, as the principal outcome, facilitate EIIs and VET institutions efforts to transition the workforce and meet future needs related to Energy Efficiency improvements and Industrial Symbiosis. In meeting the emerging demands of the industry, the basis for highly skilled employment is established and the foundations for attracting and retaining talented people to the process sector laid down, thus keeping jobs in Europe and fostering smart, inclusive and sustainable growth.

A key aim for the underlying skills strategy is to monitor and shorten the implementation of industry relevant qualifications on a company level, but indirectly also in national VET systems, continuously. The SPIRE-SAIS strategy, in parallel with developed modules and tools, already became a Blueprint for the immediate updating and implementation of new skills in industry and into national VET systems, involving a complete network of SPIRE sector actors in a common Skills Alliance. With this industry driven skills agenda and strategy, we became already part of the Pact for Skills founding together with the ESSA Blueprint the Large Scale Partnership Energy Intensive Industries (LSP EII) being an inspiration for other Blueprints and LSPs as well. Meaning, that the developed Blueprint is and will be developed further with the solutions/blueprints of other sectors and regions; looking at a common overarching European Skills Agenda harnessing synergies and leaving space for sectoral (and national) specifications.

European added value

Countries are relying more and more on key-enabling technologies and processes to boost productivity, efficiency and innovation. Nowadays, this innovation and competitiveness process is mandatory to strengthen the European economy and cannot be framed only at a local, regional or national level. A systematized and comprehensive European sectoral skills strategy is necessary to ensure:

- Added growth of the sectors involved and to ensure that trends (global, societal, technological and educational) are faced in a coordinated way;
- Demand for skills by industry is answered in an on-time and cooperative manner;
- Awareness to increase the appeal of industry careers.

Indeed, the need for an EU wide collaboration is also due to the following reasons:

- The need for a European cross-sectoral skills alliance and framework that gives orientation for a proactive adjustment of skills and qualifications in line with the new technological developments for Industrial Symbiosis and Energy Efficiency, and not to forget: to increase innovation and growth based on higher qualified people.
- To set-up a rollout of the European Framework ensuring with an open coordination leeway for its adaption, modification to different national, regional VET systems
- Scarce understanding of valuable EU initiatives: SPIRE-SAIS connects the European system for IS qualifications/training modules created with existing EU principles, tools and policies in the technological, educational and employment fields. This maximizes the positive impact of the blueprint to be developed and consequently the transparency of this skills strategy. Assurance about the strong link between project objectives and EU policy background is offered by the successful work of project partners and their initiatives at national, regional and EU levels (as can be understood by the long list of reference projects provided by this consortium).

The need for European cooperation derives from the disjointed and limited work undertaken in the various sectors concerning future skills of the workforce. The improvement of Industrial Symbiosis and Energy Efficiency has to overcome the fragmented project, company and sector related undertakings. In line with the technological development, we need a better understanding of future skills needs. It is within this context that current VET offerings become disconnected from the emerging skills needs: Therefore, European cooperation between VET providers and industrial partners offers the optimum potential for the efficient shaping of VET for anticipating change. The European level of cooperation identifies where uneven regulatory responsibility for VET at the national level creates gaps in European industry sector provision. In this regard, a European level strategy can overcome the recent fragmentation by identifying common training gaps and spreading best/good practice and at the same time understanding where the equivalences of national VET schemes might be made. The European cooperation between official national, regional and local regulatory bodies across the EII sectors is necessary for not reinventing the wheel several times and referencing skills adjustment and recognition. European cooperation is needed for recomposing the full skill set in a shared area where the EIIs sectors can source any skill or its VET provision.

1.2.3 SPIRE-SAIS Partnership: A European Industry Community Involvement

The European Commission's Sectoral Blueprints Program underlines that multi-sectoral, multi-stakeholder, and multi-level cooperation is an important factor to support up-/reskilling actions and to enhance competitiveness of the industry by a well and high skilled workforce. Therefore, the SPIRE-SAIS project consortium was composed by the main European different sector stakeholders, integrating companies, education and training providers, associations and social partners, and research institutions. All in all, SPIRE-SAIS comprises 37 partners (24 consortium partners and 13 additional associated partners up to now) from 12 EU countries (Northern, Eastern, Western and Southern Europe): and, the former EU member state, the United Kingdom (see Figure 7below).

Figure 7: SPIRE-SAIS Partnership

The transnational and multi-stakeholder composition of the partnership is based on an integration of covering now explicitly 10 industry sectors (Chemical, Water, Ceramics, Raw Materials, Cement, Railway Supply, Non-ferrous Metals, Minerals, Engineering, Refinery, Pulp and Paper) ensuring the integration of the sectoral demands and support for the further implementation of the Blueprint.

The dedicated main roles of the different stakeholder groups are:

- **Companies and social partners** are central and engage with SPIRE-SAIS aims and objectives for skills needs identification and analysis, and the upskilling of the workforce for the overall contribution to competitiveness, through database and foresight tools as well as training module development.
- **Education and training providers** contribute to the creation and development of the network by assisting in conducting analysis of existing training and qualifications frameworks and development of new programmes and curricula as well as supporting training modules development.
- **Universities and research institutions** offer state of the art knowledge of the technical and social dimensions of European energy intensive industries. These partners have long-evidenced engagement with the industry through project partnerships and training module development, as well as technological research and development activities. The research institutes provide the social and technical basis of the skill needs analysis and contribute to skill requirements and foresight in respect of Work 4.0, as well as contributions to the analysis of national VET requirements, regulations and systems and Blueprint development, including training and train the trainer modules and the interrelation to existing EU tools (like ESCO, EQF, ECVET, etc.). A contribution to policy recommendations (including collaboration with EU and Member State stakeholders, national funding institutions) is also coordinated by the research institutes.
- **European and sectoral associations** provide their expertise, give feedback, access to their respective members, and support measures for transfer, implementation and monitoring, cooperation and dissemination activities at EU and Member State Level, supporting national rollout preparation and collaboration with other blueprint developing sectors.
- The contribution of **sector experts** is for integrating their knowledge of areas covered by the project, to get sound feedback on Blueprint processes and progress, as well as key contribution to policy recommendations and transfer, implementation and monitoring processes.

The partners bring together the full range of stakeholders and perspectives required to establish a sustainable strategic sector Skills Alliance (SPIRE-SAIS) and ensure the Europe-wide delivery of a sector-wide skills Blueprint that engages with national VET systems and cross-European frameworks to meet skill needs. Especially the integrated sector federations, associations and unions are not only essential for representing the economic sector form different perspectives but also for contributing directly to the rollout of the Blueprint and informing its strategic direction.

In short, partnership and skills alliance are integrating the complementary skills of all partners for stakeholder networking, policy making, training delivery and integration, and Europe wide dissemination and implementation – all of which is needed to create such a competitive initiative. The partnership is for a Blueprint that creates a future vision for the industry and engages

companies, trade unions, universities, training bodies, and industry and dissemination networks for the continuous development of a competitive set of skills for the European Energy Intensive Industries.

Building transnational networks and cooperation tools

In order to prepare an **EII-driven** and coordinated EU skills agenda and Blueprint strategy for immediate and enduring implementation of new skills demands related to IS and Energy Efficiency targets, different partners representing industries, VET providers, workers and industrial associations join their efforts in the present project.

The project builds on the public-private-partnership coordination of the energy intensive industries via the partner A.SPIRE and the embedded industrial sector associations as intersection and communication links for the engaged sectors (Steel, Chemicals, Minerals, Non-ferrous Metals, Water, Engineering, Ceramics, Cement, Pulp and Paper, Refinery). Based on this, cross-sectoral cooperation and interchange not only improves the training and qualification activities, but also the "intercultural" exchange between the different sectors in general. Industrial Symbiosis and Energy Efficiency gave a new cross-sectoral embracing push going far beyond the existing (single) project and individual sector perspective.

The SPIRE-SAIS Alliance established a concerted action, focusing on:

- Workers' training and continuous formation
- Recruitment strategies for a young workforce and talents
- Research
- Policy recommendations and guidelines
- Transfer, implementation and monitoring.

These units worked in an interrelated and co-creative way, guaranteeing the integration of different perspectives on the subject and ensuring the sustainability of the skills strategy by direct involvement of stakeholders in the innovation development, by making them a part of the solution and long-term strategy. Setting up the development of the Blueprint as an **industry driven social innovation** process means that technological, organisational and social aspects and impacts were considered right from the beginning of the process in parallel, in an interrelated way. It means also that the workers, trainees and responsible managers of the companies were included in the development process, integrating their knowhow and ensuring their view on both demands and solutions.

1.2.4 Target Groups

Nowadays some first examples of IS and circular economy platforms are available in the EU, aiming at promoting the productive reuse of residues/resources, in the widest sense of the term. The creation of companies' networks operating in different sectors, as well as projects, solutions and integrated approaches is the basis for the realization of such a framework. The benefits of a transition to a circular economy and to sustainable business models, which allow an efficient management of resources on the territory, are increasingly evident, by extending the interest also to the conservation of the techno sphere and the biosphere.

Against this backdrop, SPIRE-SAIS is classifying and updating the skills which are required within the EU Process Industry, to enhance its capability to fully understand and catch all the opportunities for cross-sectorial cooperation aimed at ensuring a sustainable growth as integral part of its competitiveness in the global market. In this sense, the beneficiaries of the project are directly involved: companies, training providers, associations and social partners (and thus

workers and students as learners) by being part of the consortium. The main associations (A.SPIRE, ESTEP, IMA, EA, WE, ECEG, EIT Raw Materials, ECEG, Cerame-Unie, CEFIC, and CEMBUREAU) guarantee the exploitation, transfer and dissemination of the results (the Blueprint) to their member companies and national associations, which are not directly involved in the consortium activities. A.SPIRE informs the research and training developers of its support and working groups, the social partners will be informed by IndustriALL (European Industry Union). Thus, all potential beneficiaries are targeted.

As for target groups, the main direct target groups of this project are the companies themselves (specifically their training centres and HR departments) and the VET providers and institutions that are requested to adapt their curricula to the new realities in the different sectors (also to a certain degree to the industry sector as such), following ongoing technological, market and legislative (at EU and national level) demands. The project results were disseminated through the companies and VET partners, as well as through the national associations indirectly involved (by exploiting their networks and connections to the relevant national institutions). The overall aim is to have a positive impact on every government's VET agenda and institutions, learning from the industry demands for future employees.

The second group of beneficiaries are the workers and students themselves. By disseminating our Blueprint and training framework to the companies, its associations and social partners apprenticeship, dual and tertiary education as well as continuous VET and lifelong learning within the companies and training providers we deliver new and evolving curricula requirements to the upcoming staff of the industry (and the industry sector as such) based on the needs of the employers. Employability will be directly improved for those workers and apprentices able to participate and access information through online courses.

Against this general SPIRE-SAIS background and approach, the following chapters 2, 3, 4, 5, 6, 7 will summarise the main activities and results of the specific work packages (see overview in Figure 3).

2 Technological and Economic Development and Foresight (WP2)

The development and implementation of technical solutions and operating practices related to Industrial Symbiosis and Energy Efficiency is closely related to the technological development, which is an ongoing process involving both the production processes and the auxiliary service. New Industrial Symbiosis enabling technologies, such as novel treatment processes for by-product extraction and valorisation, water purification and energy transformation, advanced waste heat recovery systems, and Carbon Capture and Storage (CCS) or Utilization (CCU), lead to an increased uptake of the Industrial Symbiosis concept, that consequently affects all areas of the process industries involving all the workers: from top management to technical personnel and plant operators. Moreover, some technological developments in ICT enable information exchange between different companies and among companies and stakeholders, thus further enhancing the possibility of cross-sectorial cooperation. The 2018 Amendment (Directive (EU) 2018/851) to the Waste Framework Directive (2008/98/EC) (European Parliament & Council of the European Union, 2008, 2018) instructs Member States to prioritise Industrial Symbiosis and DG GROW commissioning a pan-EU Industrial Symbiosis network supported by an ICT platform to facilitate mainstream uptake of Industrial Symbiosis may underline the relevance of this topic given on a European level.

Against this backdrop and in line with the general SPIRE-SAIS approach and objectives, this work package (WP2) was the starting point of SPIRE-SAIS by evaluating the technological and economic development in the energy intensive industry of today and tomorrow. It is setting the ground for the analysis of the (company) skills requirements and the anticipation of the (future) support of the Vocational Education and Training (VET) systems to close the skills gaps in the energy intensive industries shortly and systematically across the sectors.

2.1 Objectives

The objective of WP2 is to assess the current state and future trends of the implementation of Industrial Symbiosis (IS) and Energy Efficiency (EE) solutions within European process industries. This includes the analysis of:

- Upcoming techniques and developments based on the main Circular Economy transformation levers, related projects and technological market trends
- The current state of the implementation of the IS and EE concepts in the European process industries, including the transactions of energy and material flows
- The effects of IS and EE on the workforce
- Different technological and economic based challenges for Industrial Symbiosis and related Energy Efficiency informing the Blueprint strategy.

With this, the future development of a sustainable process industry with a focus on impact on the personnel was considered. In close cooperation with the process industries represented by the involved sectors and their training providers, enhanced by feedback and input of all consortium partners, the future technologies of the process industries operation in the next years were investigated, incorporating the main categories of technological developments together with the related required skills and competencies.

This background was addressed to the affected sectors, processes and areas of the production cycle and to the affected personnel, in order to assess the adequacy of the current skills and gaps to be filled, the competencies to be provided to the already employed personnel and the eventual new professional profiles to be searched and formed. On this subject, new challenges coming from the Industrial Symbiosis technical developments were considered, not only by promoting the skill integrations, but also attracting and training workforce with new skills and a greater ability to work across sector boundaries.

2.2 Methodology

The adopted methodology is based on an integrated approach, collecting all the necessary information through **desk research**, including European funded projects, scientific literature and official and public documents of the relevant SPIRE sectors, and a **survey** addressed to European companies of the involved sectors. Furthermore, future trends and existing foresight analysis tools, mainly looking at the internal sectoral developed, have been analysed to define a future scenario for process industry operations in five / ten years in the main involved sectors. Specific objectives on IS and EE for each sector, including effects of IS and EE in terms of new skills requirement and training needs have been provided.

2.2.1 Desk research

The desk research analysis focused on Industrial Symbiosis has examined the most concrete examples in scientific literature, case studies and research projects aiming at optimizing resources use and to reduce 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 utilization as inputs of other industries, transactions of utilities or access to services, and cooperation on issues of common interest, according to the 4R (Reduce, Reuse, Recycle, Restore) approach for the waste management. On the other hand, the part of desk research analysis focused on Energy Efficiency has been based on improved solutions for reducing energy use, environmental impact and cost savings. In addition, synergies among companies for optimizing energy consumption have been analysed for achieving a common production and to reduce the fossil fuels utilization and, consequently, the carbon footprint, the investment, maintenance, and management costs of the energy infrastructure.

2.2.2 Survey

The survey developed for investigating the current state of IS and EE in EIIs included a set of mandatory, filter, and open questions. It was organized into three main sections (see Figure 8):

- **Section I** covers the ongoing and foreseen implementation of IS and EE as well as the expected benefits. This section is split into two similar subsections, each one dedicated to one of the covered topics, as companies might also being implementing or foresee to implement solutions and practices dealing with one only of the two considered topics.
- **Section II** is dedicated to the technical aspects and covers the envisaged resource synergies, the adopted tools, the main actors and areas which are involved in the ongoing or foreseen implementation of practices for IS and EE. Similar but separate questions target IS and EE, as companies might also being implementing or foresee to implement practices covering only one of these aspects. The questions are accessed by the compilers, who have answered positively to the initial questions of Section I concerning the involvement of their companies in practices related to IS and EE.
- **Section III** covers the foreseen impact of IS and EE on the workforce and contains both generic questions and questions dealing with only one of the two topics concerned.

A fourth section is also present, which is devoted to the collection of general information concerning the participants. It is not mandatory to fill all the fields: only the sector and the size of the company are compulsory. In particular, no personal information is required from the participant and even the name of the company is provided only on a voluntary basis.

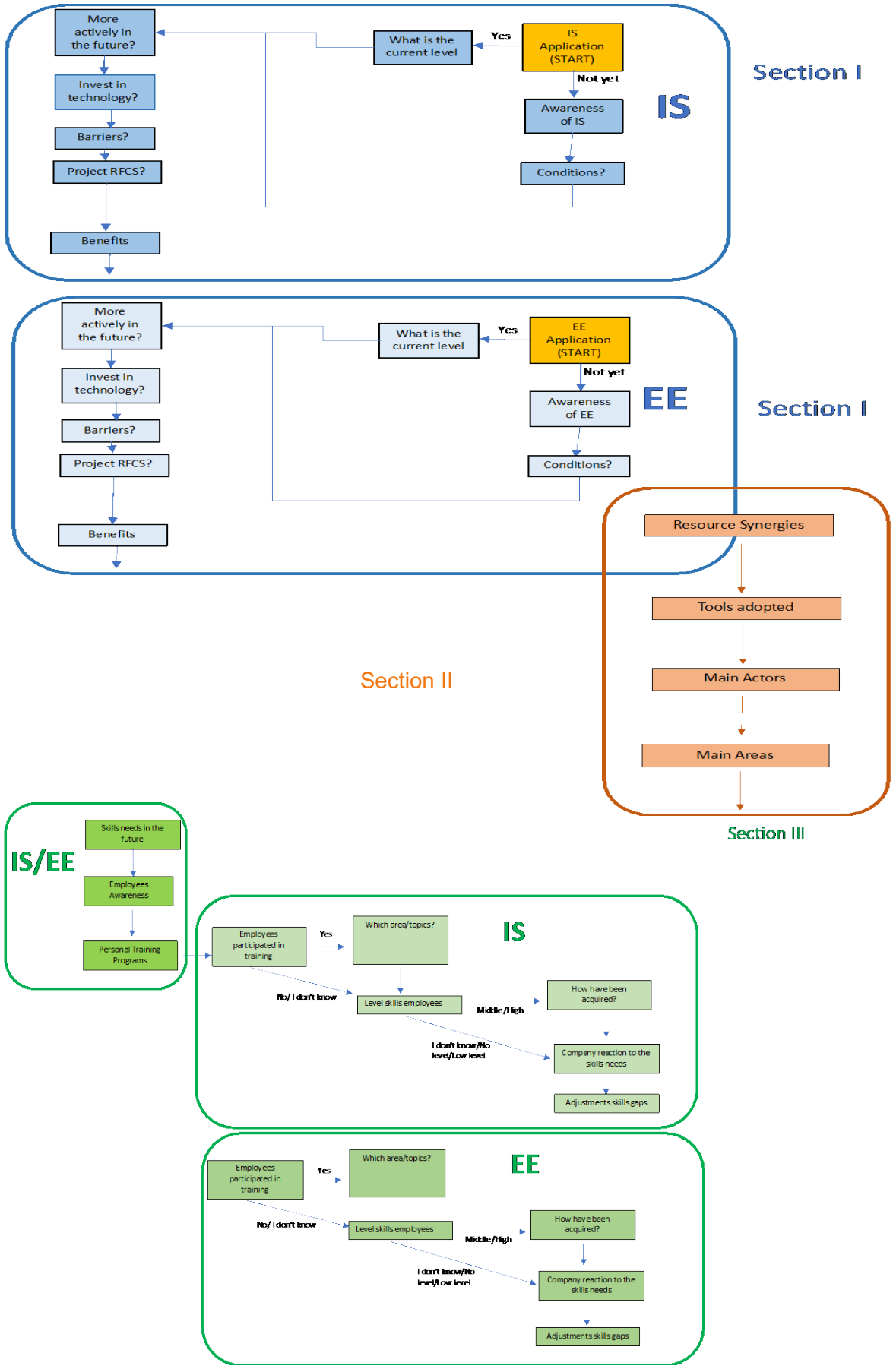


Figure 8: Sections of the Online Questionnaire

2.3 Results

The performed analysis on the current state of IS and EE in the different sectors of European process industries was based on the identification, evaluation, and synthetisation the existing scientific literature, case studies and research projects on the different considered A.SPIRE sectors (Iron and Steel, Chemical, Non-ferrous Metals, Mineral, Water, Cement, Ceramics, Cement and Waste treatment). The assessment of the main lines of research in IS and EE included in more recent updated studies, published case studies, reports, EC documents and European projects has been performed. General information about the involved industrial sectors and production processes, the generated physical flows, and the created environmental and economic benefits, as well as drivers, barriers, and enablers of both IS and EE in EIIs have been retrieved. Furthermore, the different number of references among the various sectors was due both to a non-homogeneous implementation of IS and EE activities across industries and to differences between higher implementations of IS compared to EE practices.

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 basis for a complete state-of-the-art on IS and EE implementation in process industries. The analysis was completed by an online survey giving direct insights from the companies

While a detailed analysis is provided by Deliverable D2.1 (Branca et al., 2024) and in a resulting published review paper (Branca et al., 2021) and (Branca et al., 2022) the following chapter is summarising the results of different technological and workforce related challenges for Industrial Symbiosis and Energy Efficiency, serving a sound ground for the analysis of industry skills requirement (chapter 3, WP3) and the VET system support (4, WP4) but also appear for the Blueprint strategy and its Prototype (see chapter 4.3, WP5).

2.3.1 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. New synergies across sectors and more collaboration with policy makers can pave the way for developing new symbiosis synergies and future scenarios, taking into consideration material scarcity, decarbonization of industrial processes, and stricter environmental policies. New decision-making approaches in order to achieve strategic objectives can support EIIs in the solutions' transferability across sectors and in strategies' development to overcome barriers. *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. Finally, new and innovative technologies, such as advanced materials, smart sensors, and automation, can provide new tools and processes that can drastically improve EE in EIIs, unlocking further

efficiencies and set new benchmarks for energy consumption. In this context, the future of EIIs will be characterized by its ability to adapt, innovate, and integrate EE into their industrial operations.

2.3.2 Workforce Development

Related to these technological and economic developments, the *workforce adjustment* for IS and EE 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.

To achieve the climate targets in the next few decades (according to the European Green Deal), new skilled workers and trained professionals will enable the energy and green transition. In addition, the transition from Industry 4.0 to Industry 5.0 aims to develop new systems using renewable energy and reducing waste through the collaboration between man and AI. In this context, successful training and education initiatives developed along with dedicated structures, both at local and regional levels, will boost energy, green and digital skills and strategies to address the future challenges in EIIs.

2.3.3 Survey Results

The survey included 81 valid answers. Participants belong to partners of the SPIRE-SAIS project but also to other companies. Although the sample was small, respondents derived from eight A.SPIRE sectors (see Figure 9) in different European countries.

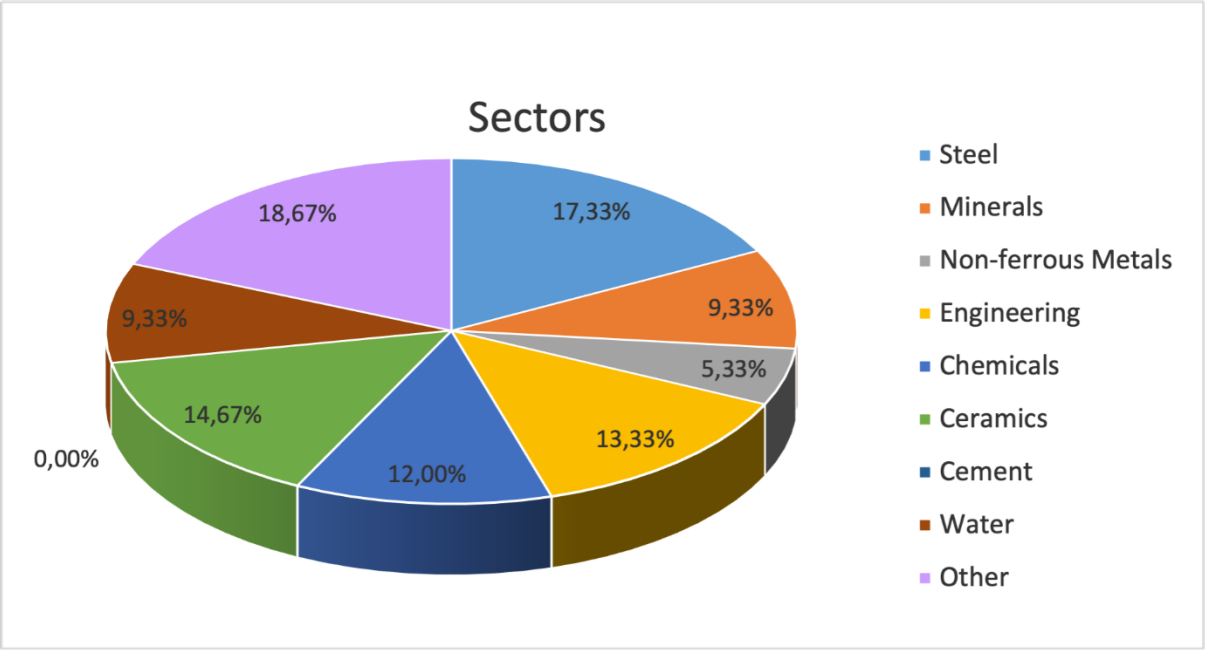
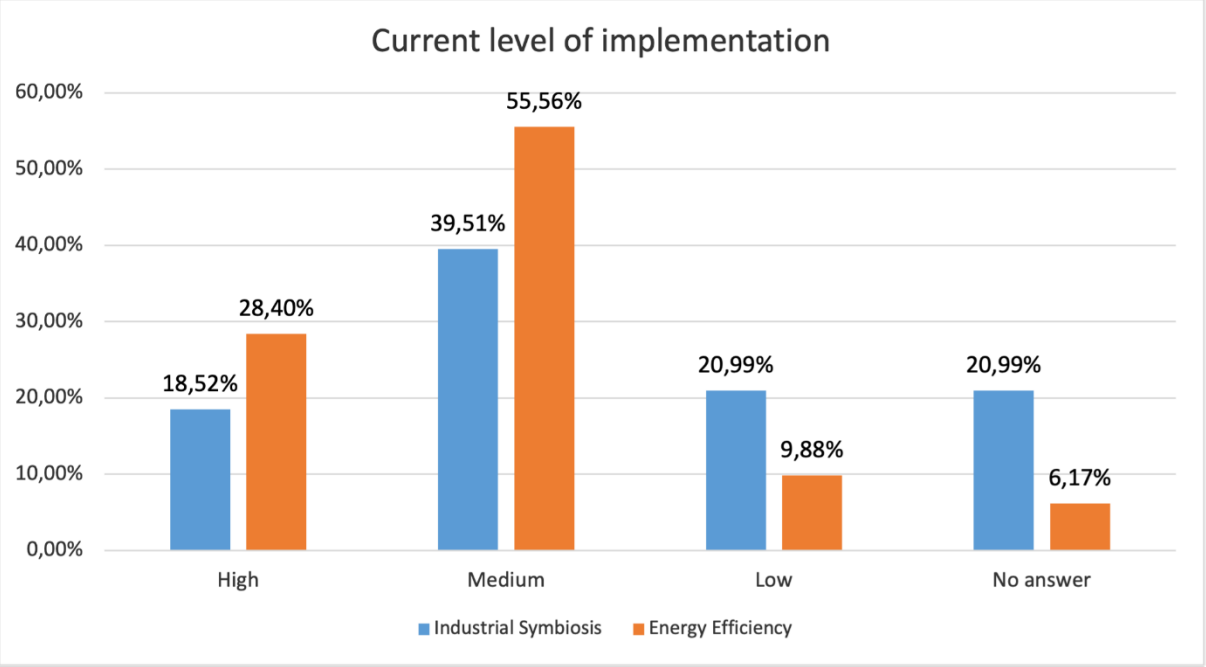


Figure 9: Distribution of participants among different sectors

Additional to the desk research, the *company survey* across the different sectors reflected 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 perceived 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 10).



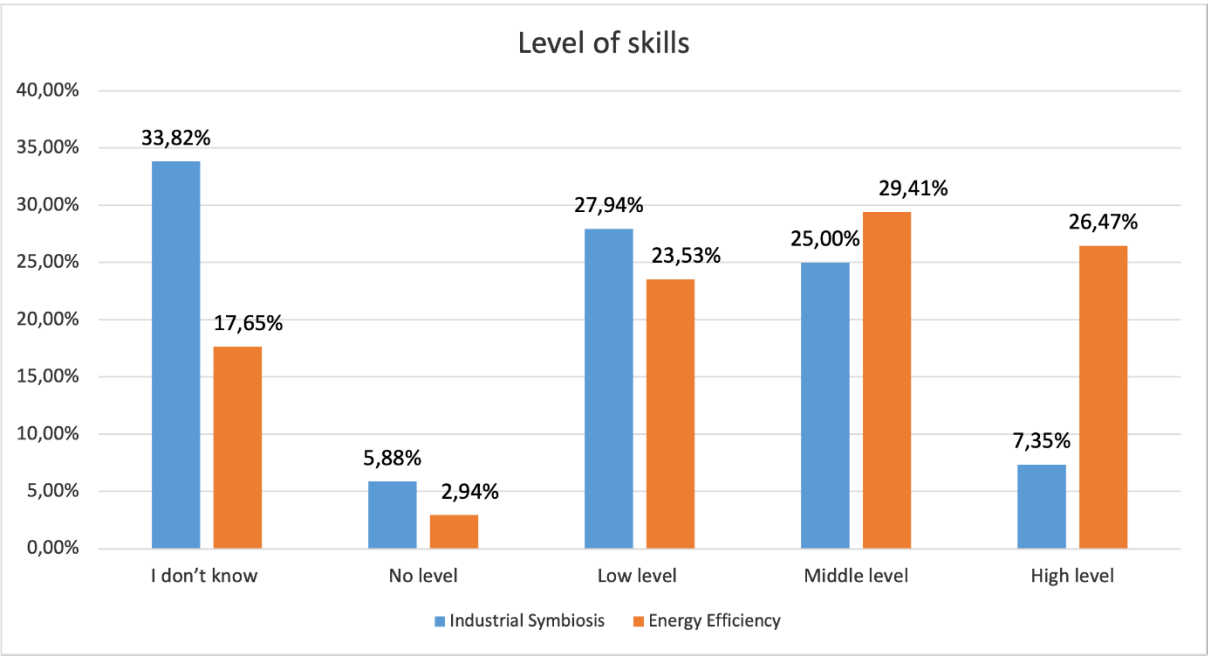


Figure 10: Technological Implementation and Level of Skills

By implementing Industrial Symbiosis and Energy Efficiency the company expects a broad range of economic *benefits*. In particular, the application of IS practices can produce reduction of costs for waste disposal, increased sustainability of the production process as well as increased overall competitiveness. On the other hand, the application of Energy Efficiency practices is expected to provide higher benefits in terms of overall Energy Efficiency, increased sustainability and increased competitiveness. Concerning environmental aspects, Industrial Symbiosis is expected to mostly lead to reduction of wastes, while Energy Efficiency is expected to mostly lead to reduction of greenhouse gases emissions. However, both implementations are expected to contribute to the reduction of natural resources depletion and of ecological footprint. Furthermore, Industrial Symbiosis and Energy Efficiency implementations are expected to improve working conditions, green skills and performance of the workforce as well as new jobs (higher expectations on Energy Efficiency than Industrial Symbiosis) and professional figures (see Figure 11).

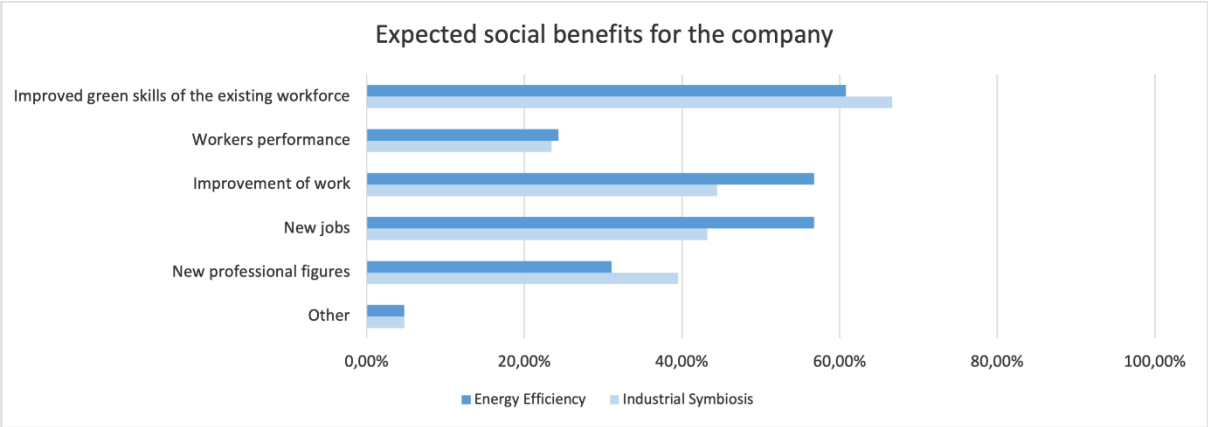


Figure 11: Expected social benefits for the companies from the application of IS and EE.

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 12).

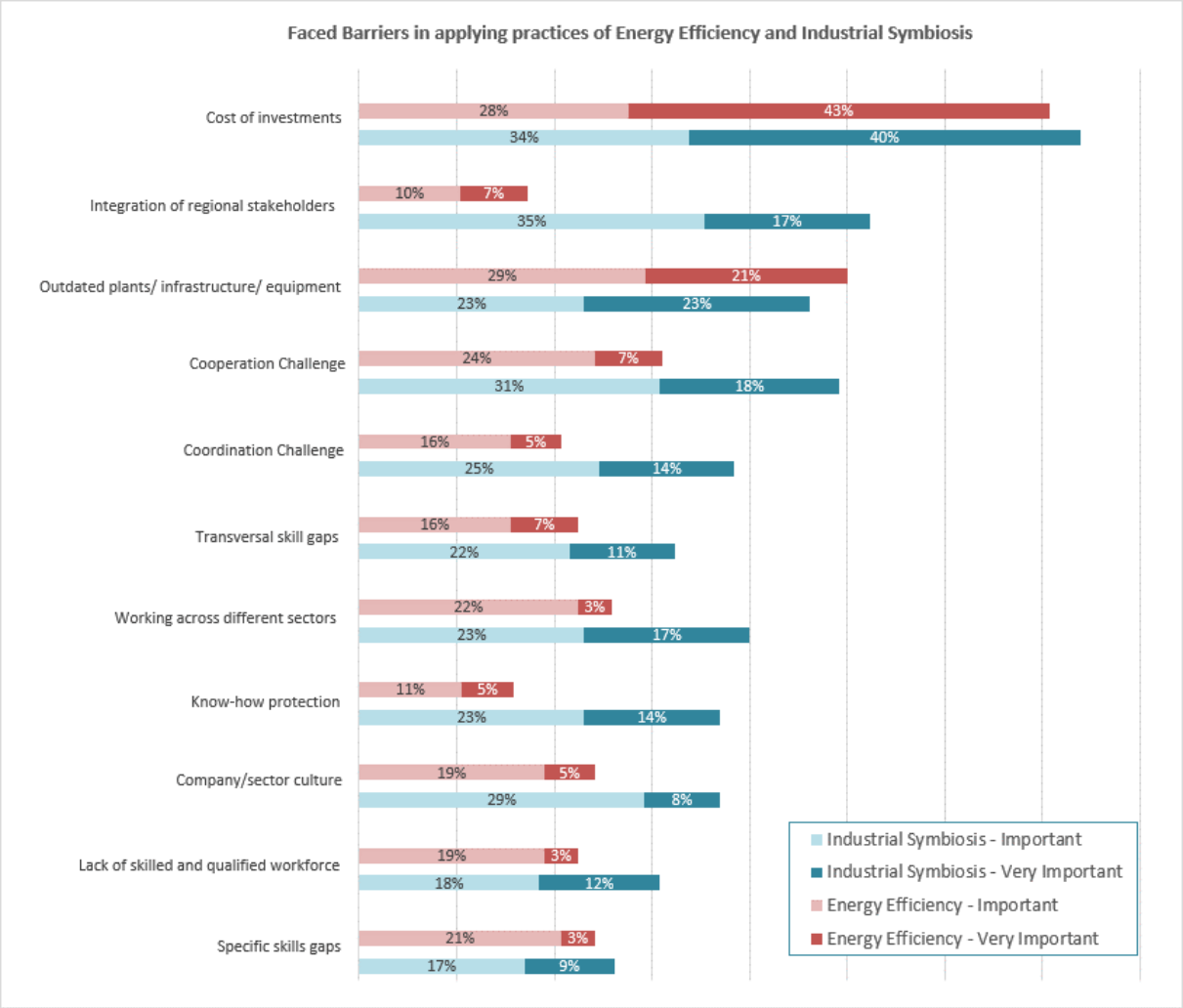


Figure 12: Barriers Faced Concerning the Implementation of IS and EE

Concerning the impact on the workforce in the incoming 3-5 years, due to the application by companies of Industrial Symbiosis and Energy Efficiency in the future, mostly an increase of jobs and especially highly qualified pro-files is expected. Other impacts are related to new research directions for developing emerging technologies including digital processing methods (e.g. additive manufacturing, use of recycled materials for high tech applications) and digital technologies as well as on attracting of young talents and developing new business lines, but also higher workload.

As skills gaps are for about one third of the respondents an (very) important barrier, the current *training measures* implemented by companies are mostly informal and unstructured. Emerging and future skill gaps will be overcome by internal and external training activities (see Figure 13). While a higher workforce performance is needed in both areas (Energy Efficiency and Industrial Symbiosis), the almost incremental upskilling is complemented by new jobs or pro-fessions especially in Industrial Symbiosis.

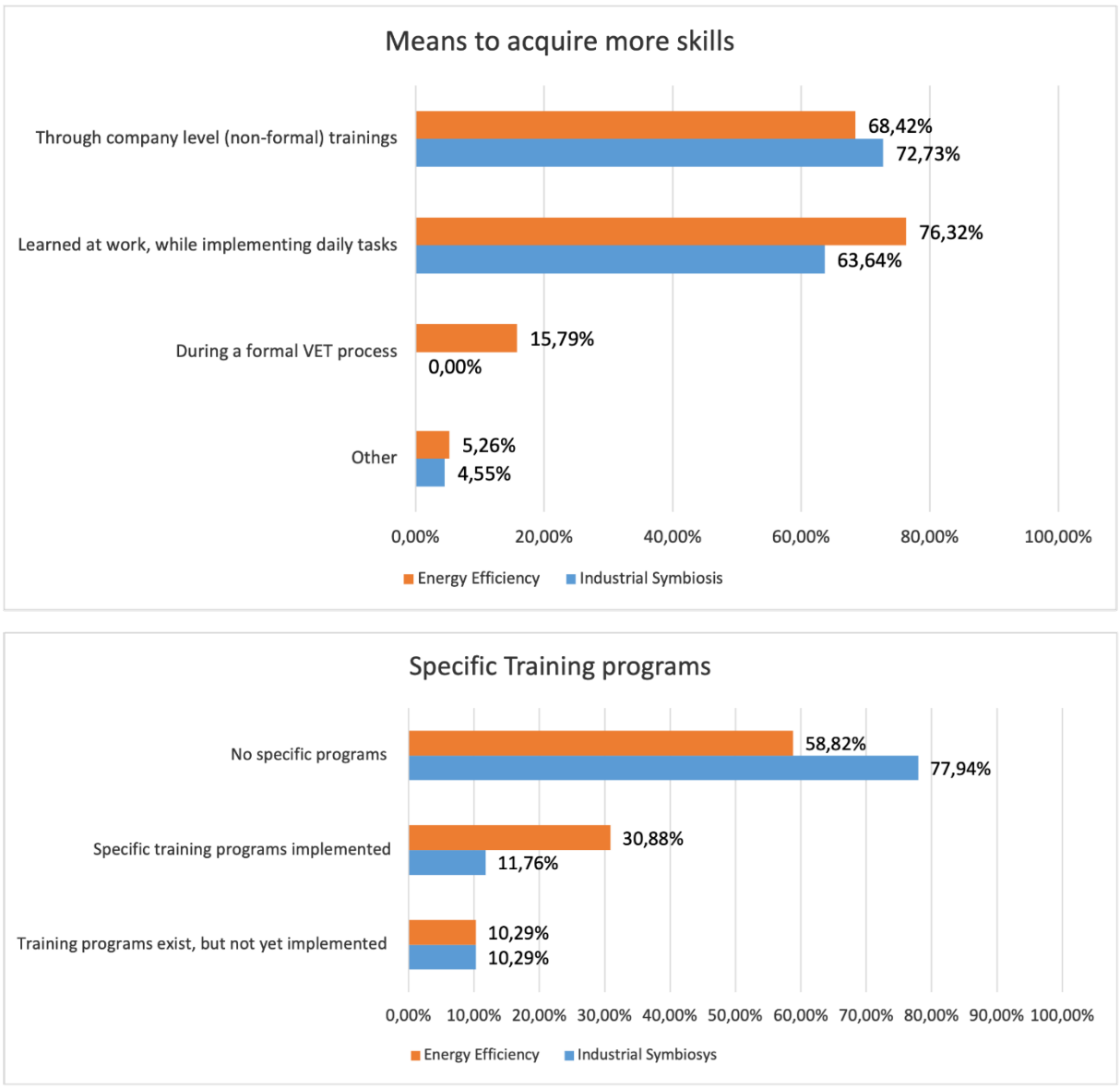


Figure 13: Skill Improvement Strategies

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 (see Figure 14). Other useful skills identified within the survey are regulatory and entrepreneurship skills. Especially low and middle level skills need to be updated.

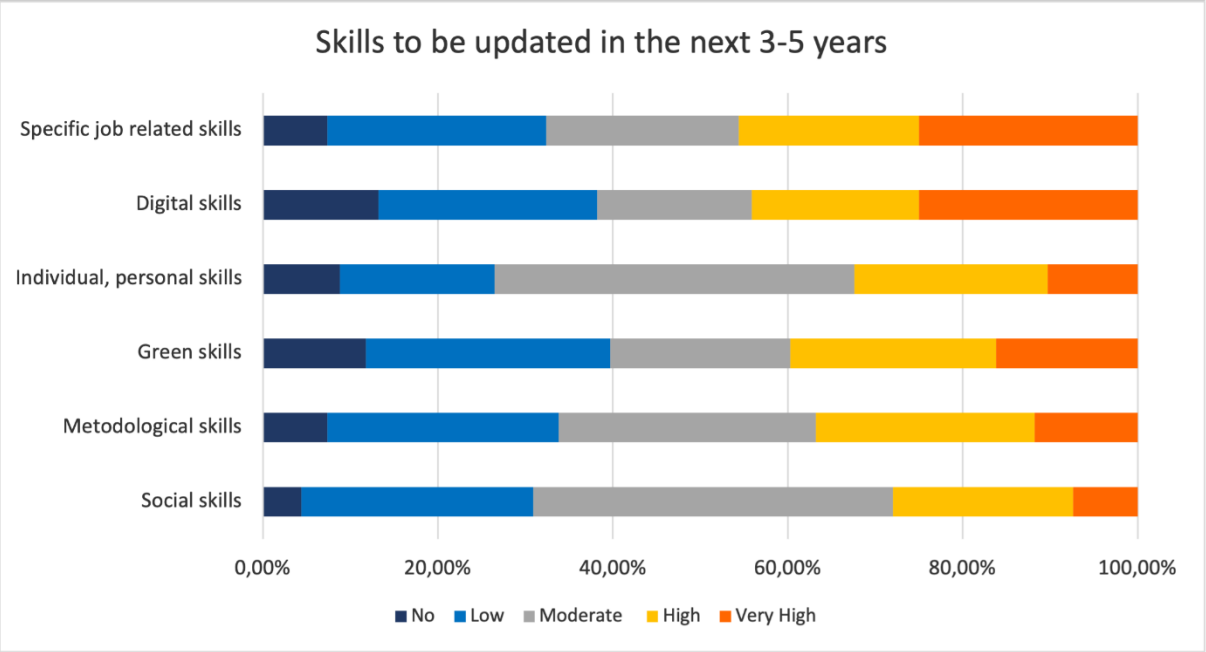


Figure 14: Needs for skills updating for the application of IS and EE

2.4 Future Scenarios

Based on achieved results, future trends and existing foresight analysis tools, mainly looking at the internal sectoral developed, have been analysed and applied, in order to define Future Scenarios for process industry operations in five to ten years. Specific objectives for each sector related to IS, EE technologies and processes as well as to new skills requirement and training in the different sectors have been analysed.

In particular, developments of monitoring systems and new sensing devices for improving characterization of process inputs/outputs to a better and targeted valorisation of by-products have been analysed. In addition, among others, the importance of online measuring and monitoring, with dedicated sensors within a hardware and software architecture have been highlighted. Furthermore, real-time data driven monitoring and process control and online monitoring system, and data-driven cloud-based control system were investigated as fundamental tools for different sectors.

Digital technologies, that will allow smart and fast information exchange and seamless connection of different industrial production cycles, for most of the involved sectors are of high importance. Other important digital technologies also mentioned are Artificial Intelligence, Digital Twins, Digital Support System, Cloud-based Smart Waste Management Systems, Robotic Systems and Model and Match-making Algorithms generating ideas for synergies as well as modelling and simulation of processes.

Concerning the future demand and market requirements with regard to environmental (greening of economy) and demographic challenges (growing aging population), the main issue for the future will be the carbon neutrality by 2050 while sustaining growth. Other important aspects mentioned are: development of new exploitation and valorisation schemes based on business models and services tailored; new governance approaches; reducing barriers for recovery, reuse and commercial exploitation of valuable resources in IS; novel models of collaboration.

Concerning the future effects of the uptake of IS on the personnel (in terms of new skills requirement and training needs), qualified people are needed to manage alignment with the legislation, including also life cycle assessments in the pilot training course for awareness, as well as concepts for recycled material and secondary raw materials.

Concerning effects of the uptake of EE on the personnel, skills and trainings designed for the optimization have been mainly indicated. Recovery of energy means new processes with new technologies and, consequently, devoted skills and trainings should be anticipated. Understanding technology trends and evolution in the field, and the ability to learn and integrate new concepts and apply new methods / technologies will be crucial in all involved sectors.

Finally, the future industrial scenario for implementation in EIIs will go one step further assessing not only resources and technologies but also the impacts and policy recommendations to achieve an effective industrial rollout of decarbonization technologies inside and beyond the EIIs.

2.5 Summary

To sum up the results of the technological, economic and related skills review the Blueprint was informed by:

- 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 15), 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).

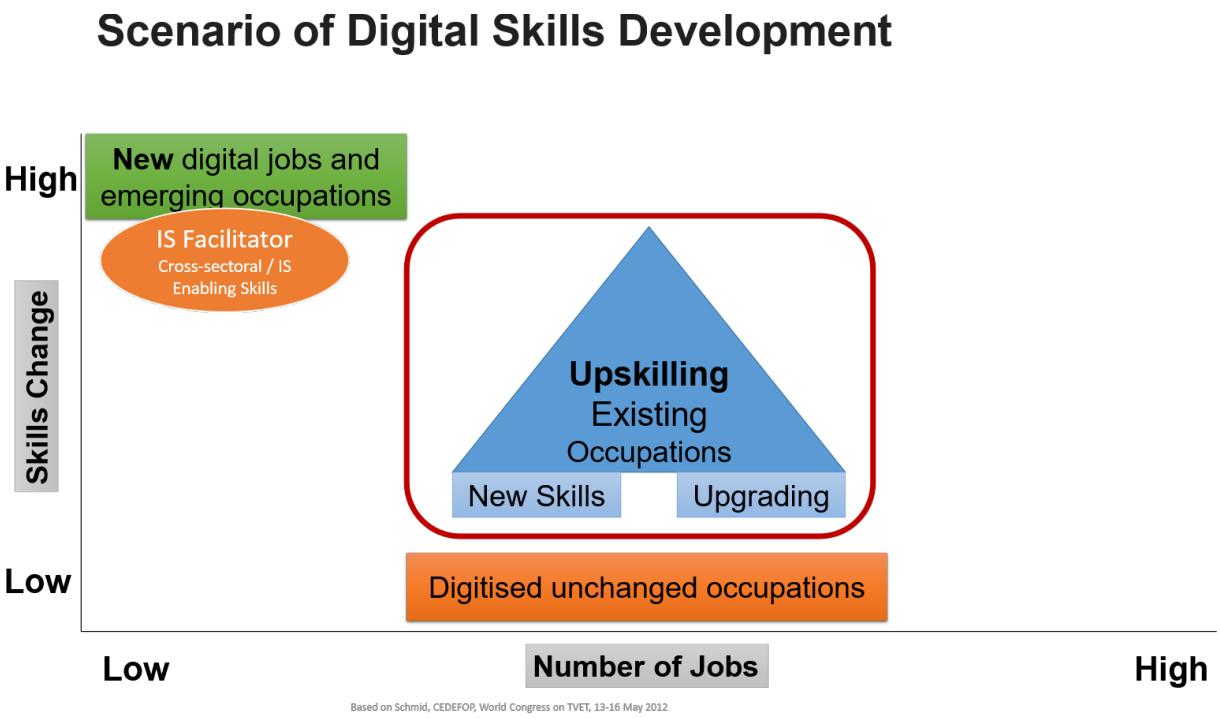


Figure 15: Complementing and Upskilling Existing Occupations are in Focus of SPIRE-SAIS

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).

In the context of the research activities, a **Project Repository,** designed for collecting material from partners was set up and will be integrated in the governance structure of SPIRE-SAIS in the Foresight Observatory (see chapter 5.3.1). This repository is foreseen as a continuously updated reference disseminated to the whole A.SPIRE community and the interested public. Its structure is organized per sector, in order to include projects based on Industrial Symbiosis and Energy Efficiency of the different sectors involved in A.SPIRE. In addition, a cross-sectoral section is present, including projects on Industrial Symbiosis and Energy Efficiency that are transversal across the different involved sectors. The repository includes the sectors involved, funding schemes (e.g. RFCS, FP6, FP7, H2020, Horizon Europe, etc.), title and acronym of the project, main key words, start and end date, short description of the project and if the project involves either Industrial Symbiosis or Energy Efficiency (or both), what kind of flows of Energy/Material are involved, the main objectives and outcomes, the website of the project and the final report (if available). The summary description of each project has been also included in the dedicated sections of the Deliverable 2.1 (Branca et al., 2024).

3 (Company) Skills Requirements and Foresight (WP3)

Based on the results of the technological and economic development the company related current and future skills requirements are defined and assessed - as a foundation for developing the potential for industry driven VET systems support, as well as advising the European Blueprint development.

3.1 Objectives

Industrial symbiosis is the process by which wastes, or by-products of an industry or industrial process, become the raw materials for another. By using this approach an interconnected network which strives to mimic the functioning of ecological systems is created, within which energy and materials cycle continually with no waste products produced. Together with Industrial Symbiosis, Energy Efficiency is another goal for Energy Intensive Industries (EII) towards higher environmental sustainability. In its revised legislative proposals on waste, the Commission is asking to clarify rules on by-products to facilitate Industrial Symbiosis and help create a level-playing field across the EU. There is as well a general trend to manage the data required to advance Industrial Symbiosis (see for example r CIRCLEAN, a pan-EU IS network supported by ICT). Further, the majority of Industrial Symbiosis opportunities lie outside one's own sector, so familiarity and comfort with other sectors must be cultivated.

Therefore, the general objective of this WP is to examine the range of essential skills, knowledge and experience that workers require to adopt Energy Efficiency and Industrial Symbiosis in daily work, and to develop upskilling and reskilling pathways for individuals and organisations that meet the actual skill needs.

WP3 has two main objectives:

(a) Identification of skills, knowledge and experience required to adopt Energy Efficiency and Industrial Symbiosis in daily work
(b) Defining skill/knowledge/experience gaps in terms of IS and EE to include in training programs and recruitment process

The first objective of this WP3 is to identify and specify these new skills and training needs within the SPIRE sectors, considering a framework of Industrial Symbiosis, Energy Efficiency and growing digitalization, to be incorporated into VET and tertiary education training curricula, making 'definition of recent and future skill needs and redefinition of professional profiles' the first WP3 task.

After clarifying the industrial changes and tasks, it is possible to interpret the data on the expected evolution of skills needs. Once this expected evolution is defined, the skills mismatch between the workforce and industry demands can be clarified. Only then, the skills gaps can be reduced by delivering well-developed continuous trainings. In terms of capacity building, both IS and EE, including their potential and benefits, should be included in the education of engineers and business students to ensure the availability of a sufficient skill base.

3.2 Methodology

In order to achieve the described goals and to deliver a sound input for the Blueprint (see chapter 4.3), main task is to define **skills needs (current and future) in term of four proficiency levels and learning outcomes and redefine professional profiles**. This was done

via a Learning Outcome Pipeline Methodology which is a systematic approach designed to create a cohesive and structured link between industry requirements with educational which is describe in Deliverable D5.3 (Schröder, Muract, et al., 2024; chapter 2.2.1).

The process started with analysis of existing professional profiles within the companies and required skills and capabilities considering the current portfolio of technologies being implanted in the last years (see chapter 1.2). We started from a reflection of the current situation of each involved company regarding applied technology and sectorial economic situation (for example, the dependency of critical raw materials and the national regulatory framework of energy market, the contribution of renewable sources to the energy mix, etc.). In addition, a literature review to identify studies about future skill needs in process industries was done. After this preliminary analysis, involved companies reviewed their current professional profiles on a co-creation basis, using questionnaires and/or personal interviews and meetings to obtain the information on affected existing (or new) job profiles and the required skills for them - allowing a first identification of skill mismatches and gaps for each profile.

Based on this process done by the companies, the next results were obtained:

- A common database of professional profiles, with an estimation of knowledge level (qualitative scale with some degrees)
- A list of current and future skills demanded for each professional profile (or profile group, differentiating the different levels: management and operation; high, medium and low skilled workers).

These results are included in the platform SKILLS4Planet, more about it in chapter 5.3.2.

Additional focus is on train the trainer and training approaches and talent management and recruiting. Concerning **training the trainer** as an input to the Training Framework (see chapter 5.3.2) we are (a) looking at new strategies and guidelines in order to get the trainers (internal or external) closer to workers, and therefore reach a greater assimilation of the taught lessons, and (b) to new process responsibilities and therefore to a new leadership (e.g. middle managers as "trainers" of their subordinates (new leadership).

Concerning talent management and recruitment (which is mainly covered by WP5, see chapter 5.3.3) we look at existing recruiting tools and strategies in the companies and sector associations to assure that key skills are detected during recruitment process (esp. related to attraction of younger generations and women).

Against the backdrop of these tasks, a five-step methodology was developed as presented in Figure 16). We have completed the first three steps of the methodology by the end of 2021. The other steps are presented in the “Next Steps” section.

Figure 16: Five Steps to Identify Job Profiles, Skills, and Learning Outcomes

Step 1: Generation of job profiles related to IS & EE in A.SPIRE sectors

Six of the A.SPIRE sectors (Ceramic, Minerals, Chemical, Water, Cement, and Steel) generated a company flow chart identifying the job profiles related with IS & EE in their sector. To achieve this goal, the following methodology was developed and applied by the defined sectoral working teams (see example of Ceramics in Figure 17):

1. The first step encompasses meetings with companies to explain the project and the main objectives of WP3.
    a) Advise 1: It is recommended to work with companies that can be considered as "average" of the sector. If possible, with Quality Management System implemented (for example ISO 9000), because these types of companies have nearly available all the information that this step requires.
    b) Advise 2: After the first meeting with the company/s it is advisable to provide them with the definitions of Industrial Symbiosis and Energy Efficiency, included at the beginning of the present document, this information will help them to identify the job profiles related to target topics.
    c) Advise 3: It should be highlighted that, although industrial partners and collaborative companies have the highest workload, the partner in charge of each SPIRE sector will be responsible for supporting the company during the process, reviewing the documents presented and ensuring that they are in line with the objectives of the project. In fact, each working team have to develop a document in which the methodology applied, and the data representativeness is described and assessed.
2. In order to develop the flow chart, it is proposed to go in detail till "intermediate management level" and to start with one or two companies trying to obtain a generic company flow chart. After it, in the case of production and maintenance, it is recommended to go beyond intermediate management level (if possible).
3. The company performed the job profiles selection related to IS and EE (based on the criteria previously discussed)
4. A datasheet of each selected job profile, related to IS and EE, detailing its mission, tasks and main relation with IS& EE was prepared. This task was volunteer, but it helped to justify job profiles selection.

5. Once the company flow-chart was obtained, its representativeness had to be ensured via a double check validation: First, the company flow chart was distributed among other subsector companies and, secondly, the obtained flow chart was validated by all the subsectors by means of the Business Associations at National and European level.

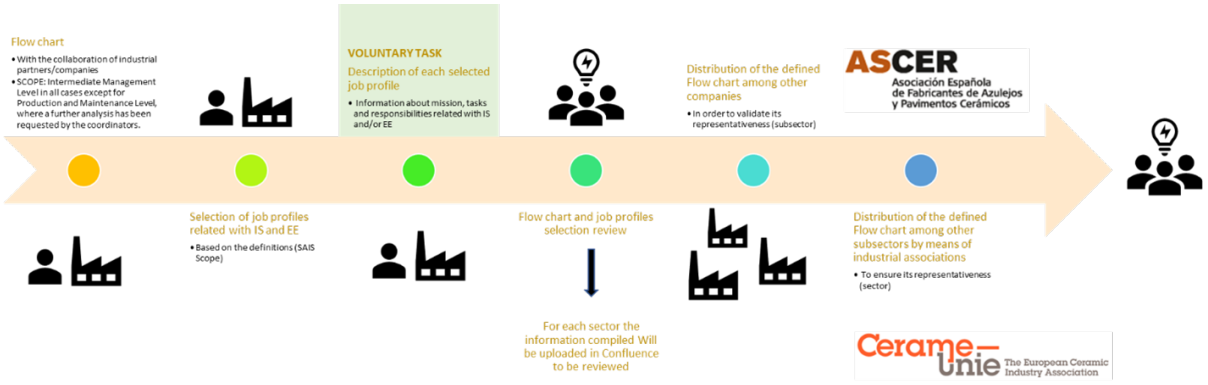


Figure 17: Flow Chart and Affected Job Profile Detection (Example Ceramic Sector)

Step 2: Identifying the equivalent ESCO occupations for the selected IS&EE job profiles

Each SPIRE sector involved matched their pre-selected job profiles related with IS&EE, with the equivalent occupations from the ESCO database, enlisted in an excel datasheet (job profile matrix). By this process, transversal occupations through the sectors were identified clearly. The matching list was finalized, reviewed and approved.

Step 3: Generation of Professional role profiles description templates

"The professional role profile template" has been defined based on 'skills' and 'tasks'. A number of skills related with IS&EE has been identified through a detailed desktop analysis and discussion of the subject with experts. Finally, the selection of skills was discussed and analysed with the WP3 partners. Tasks will be retrieved from the ESCO database. To define current and future needs of the identified skills, five proficiency levels are defined (0-Novice, 1-Awareness, 2-Basic Actor, 3-Practitioner, 4-Expert, 5-Master).

The connection of SAIS skills and profiles with EU tools are performed through (a) integrating ESCO IS/EE profiles, (b) standardizing the job profiles of the sectors by using ESCO and Professional Job Profile description template, and (c) creating a skills database for different job profiles.

Step 4: Generation of the questionnaire assessing the selected job profiles and classified skills

In order to identify relevant future skills and skills gaps, a ¨Job Profile and Skills Assessment Foresight Questionnaire¨, based on the selected job profiles and classified skills was performed, targeting the human resources experts of the energy intensive companies (see results in chapter 3.4).

Step 5: Functional Analysis of the selected occupations and creating "Learning Outcomes" pipeline

The functions of the occupation scope were identified and the knowledge, skills and competences that are needed to successfully perform the functions were captured. "Learning outcomes" are used as a link between SPIRE-SAIS skills needs and European tools (ESCO, EQF)

and national VET systems. Functions and skills are aligned with “learning outcomes” connecting the world of employment (industry) and of education and training (VET systems), for (a) talent management & recruitment purposes (b) development of training courses, tools and activities.

The industry partner brought in in their perspective and experience on train the trainer and training approaches as well as on management and recruitment as an input for the related tasks of WP5, the Blueprint development.

Finally, the training results were validated by the companies and matched with training offers - combining the industry proficiency levels with EQF levels.

However, the main focus in the final stage of the project was on:

- 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).

3.3 Results

Considering the future technological developments for implementation of IS and EE solutions within process industry summarized above (chapter 1.2) and skills development concepts stated in other recent sources (reports like Steel Sector Careers; White Research et al., 2020), McKinsey study (Bughin et al., 2018), the portfolio review of the projects on Industrial Symbiosis by the European Commission (Sommer, 2020), several book chapters and scientific articles (see D3.2; Bayón, 2024), new skills and training needs within the 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.

Following the described methodological steps, 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 was outlined by (see Figure 18):

1. Summarising the main *facts and figures of the sectors* (subsectors, direct jobs, production, energy, waste, and Industrial Symbiosis) as a background information (see D5.2 Blueprint Prototype, Schröder, 2021, Annex 7.4)
2. Creating *organisational flow charts* in different sectors selecting job profiles related to Industrial Symbiosis (see D5.2 Blueprint Prototype, Schröder, 2021, Annex 7.6)
3. Grouping similar *sectorial job profiles* and finding equivalencies with occupations of the ESCO database and ISCO groups
4. Identifying related skills and grouping them to a specific sector overarching *skills classification*
5. Developing a first template draft for job profile related skills *assessment*.

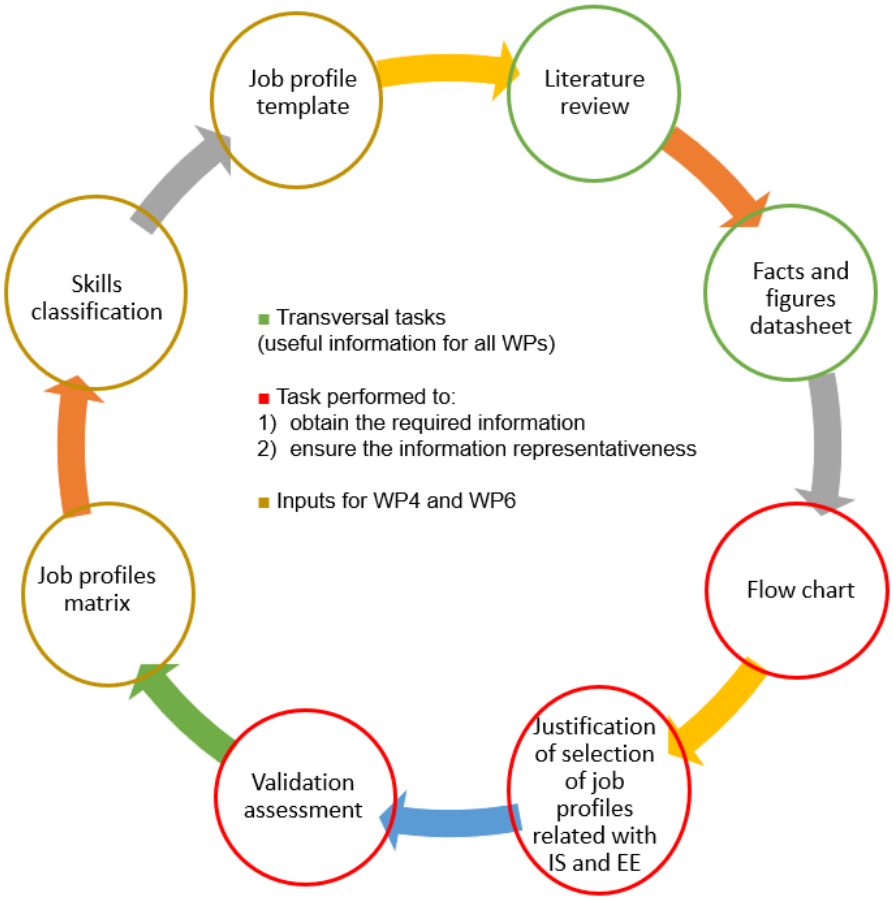


Figure 18: Overview of the main tasks done in WP3

As the literature review summarised in Deliverable 3.2 (Bayón, 2024) and the Fact and Figures (see example of Ceramics in Table 1, the whole tables could be found in Deliverable 5.3 Blueprint Prototype, Schröder, Muract, et al., 2024, Annex 7.6) 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.

	CERAMIC SECTOR		
SUBSECTORS	Walls and floor tiles, Bricks and roof tiles, Refractories, Technical ceramics,Table and ornamentalware, Sanitaryware, Expanded clay, Clay pipes, Porcerlain enamel		
DIRECT JOBS	200 000	**PRODUCTION (€)**	31 bn
ENERGY	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).		
WASTE	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		
RAW MATERIALS	Access to raw materials (bauxite, silicon carbide, magnesia, etc.) is a key factor regarding ceramic sector competitiveness		
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	A.SPIRE, 2021a / Department for Business, Energy & Industrial Strategy, 2018 / Cerame-Unie, 2012 / Cerame-Unie, n. d.		

Table 1: Facts and Figures (Ceramic Sector)

3.3.1 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 (see example Ceramics Figure 17).

Following 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 D5.2 Blueprint Prototype, Schröder, 2021, 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 important result to be highlighted is that job profiles related to EE and IS are not only those associated to the production stages but include also those from the functional areas (materials/products, maintenance, logistics, purchase, and others).

Cement

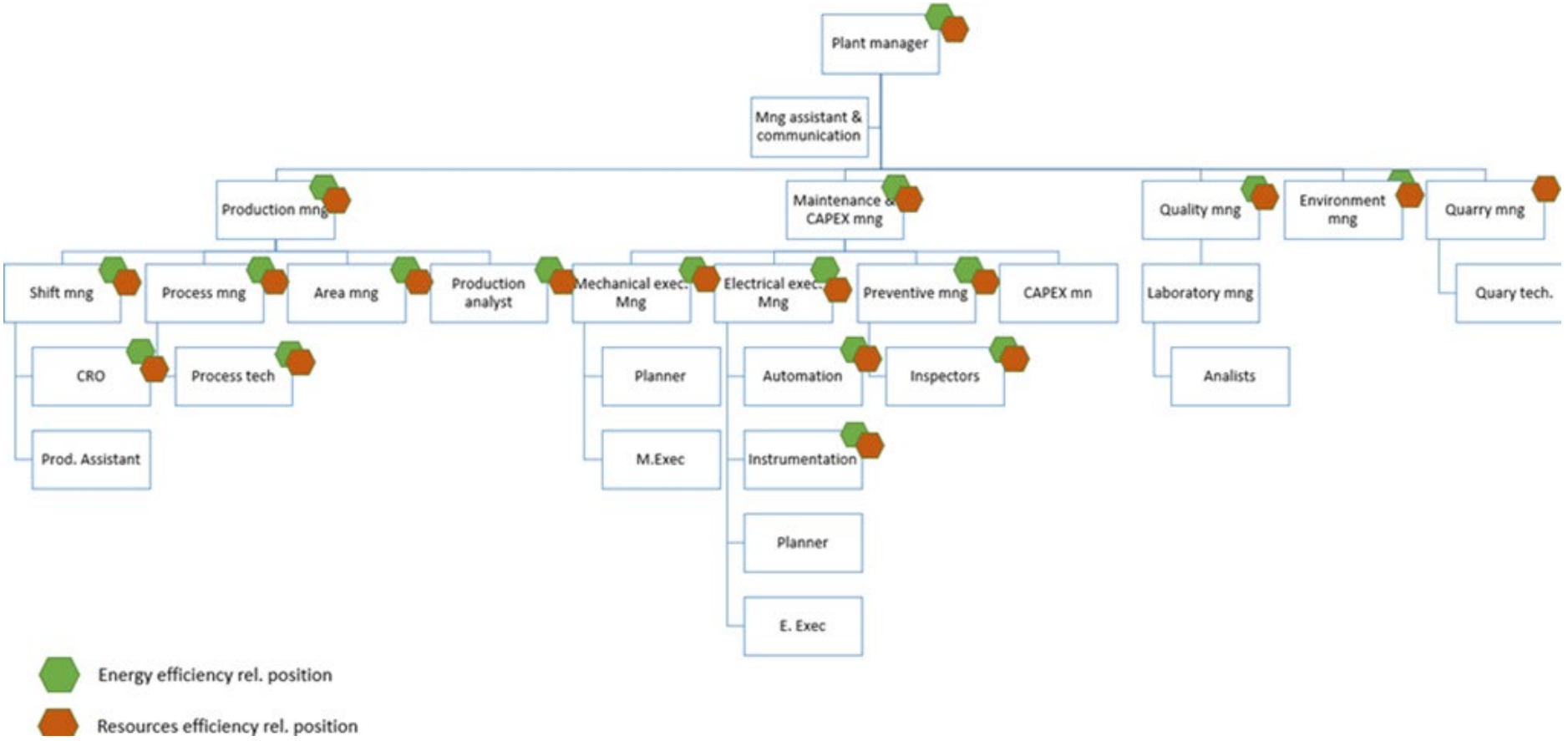


Figure 19: Organisational Flowchart Cement

Steel

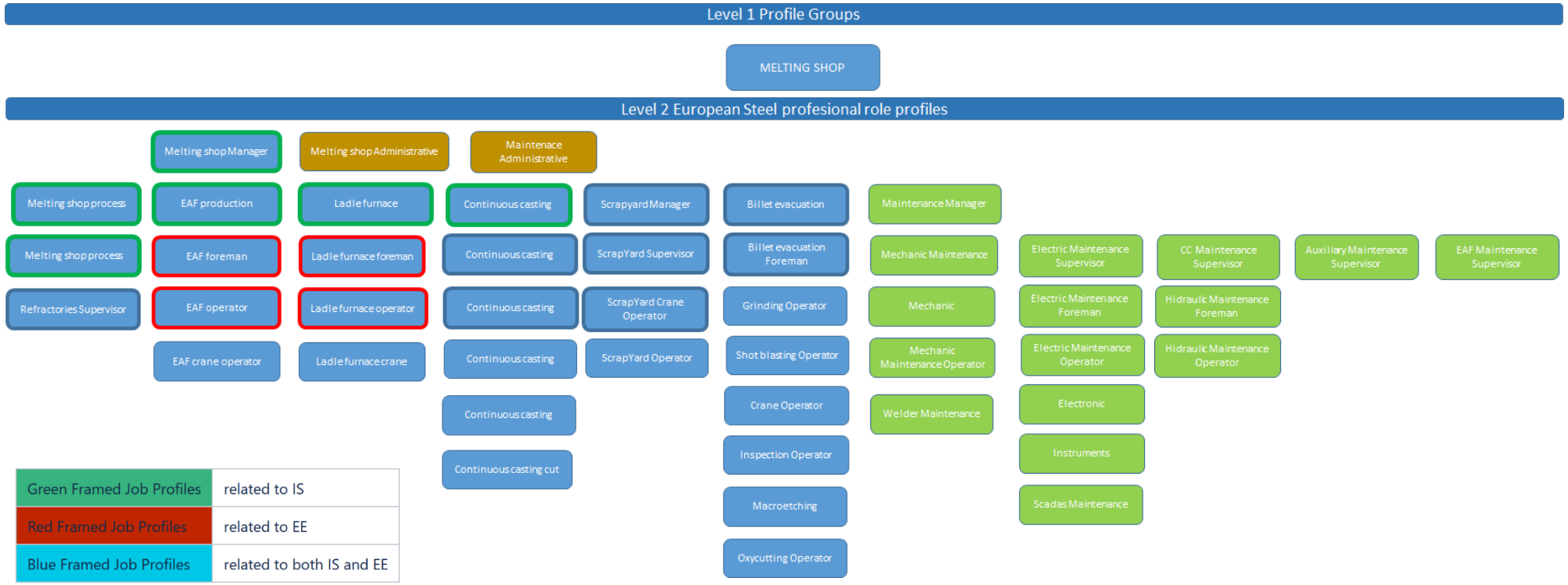


Figure 20: Organisational Flowchart Steel

Ceramics

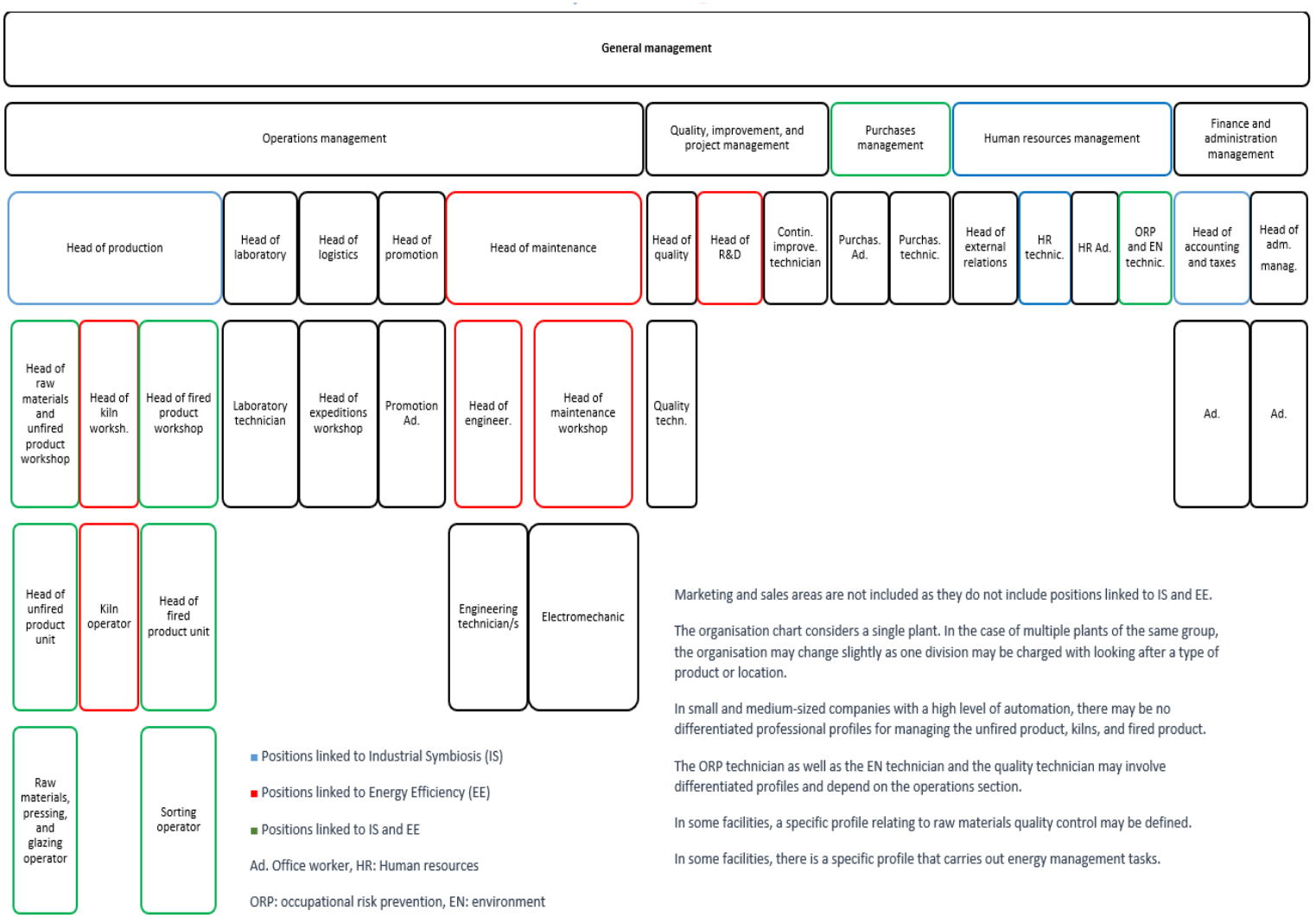


Figure 21: Organisational Flowchart Ceramics

Once the flow charts have been developed and validated, each sectoral working team develop a **representativeness assessment document** (see example of the ceramic sector in representativeness document is shown in Table 2).

	**CERAMIC SECTOR**

The SPIRE SAIS ceramic sector flow chart has been developed by ITC with the collaboration of different companies and ceramic sector associations by means of the following steps:

1. **At the end of 2020, several meetings were held with ceramic tile manufacturers to define the objective and scope of the SPIRE-SAIS project.**
2. **With this information and the ITC support, the companies developed the first draft of the flow chart.**
3. **First selection of job profiles related with IS and EE selection was proposed by companies.**
4. **This information was reviewed by ITC. At this point, to clearly justify the job profiles selection, it was decided to develop a specific datasheet for each selected job profile with the following information: mission, duties and relation with IS and EE.**
5. **Once the first version of the flow chart was developed, it was shared with the different associations at national (ASCER) and European level (CERAME-UNIE) to validate the flow chart representativeness not only for the ceramic tiles subsector but also for all the other ceramic subsectors (Walls and floor tiles, Bricks and roof tiles, Refractories, Technical ceramics, Table and ornamental ware, Sanitaryware, Expanded clay, Clay pipes, Porcelain enamel). With the received feedback, a new version of the flow chart was developed taking into account that it should be specific enough to identify the main gaps related with IS and EE but general enough to be representative for all the sector.**

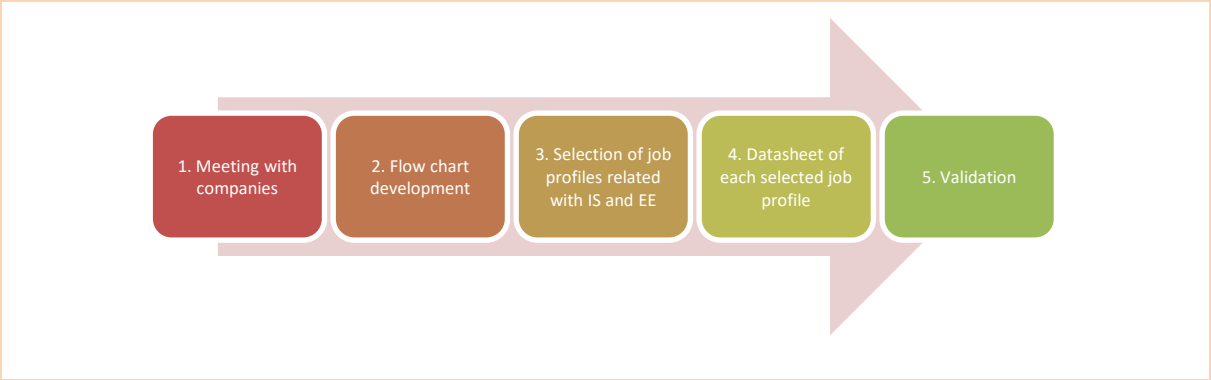


Table 2: Representativeness Assessment (Ceramic Sector).

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.

3.3.2 Job Profile Identification and Selection

The literature review, facts and figures datasheets and organisational flow charts led to a common job profile and skills selection of the different sectors - done by the involved companies and reflected by the consortium, esp. by 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 sectors 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 Industrial Symbiosis and Energy Efficiency were selected. Cross-sectoral generic job profiles of production and functional areas, each represented by a managerial and operational function, were agreed on:

- 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.

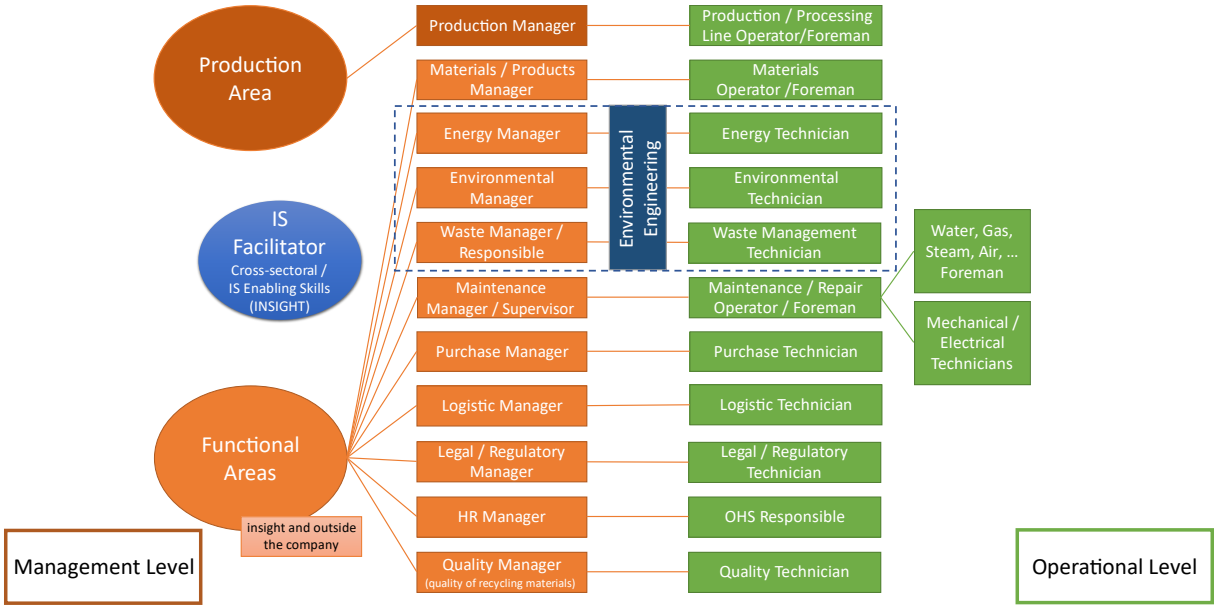


Figure 22: Cross-sectoral Generic Job Profiles and Functions for EE and IS

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 1.2) 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 23), 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 23: IS Facilitator Curriculum (Insight, 2020, p. 8)

3.3.3 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 24). 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 Figure 24.

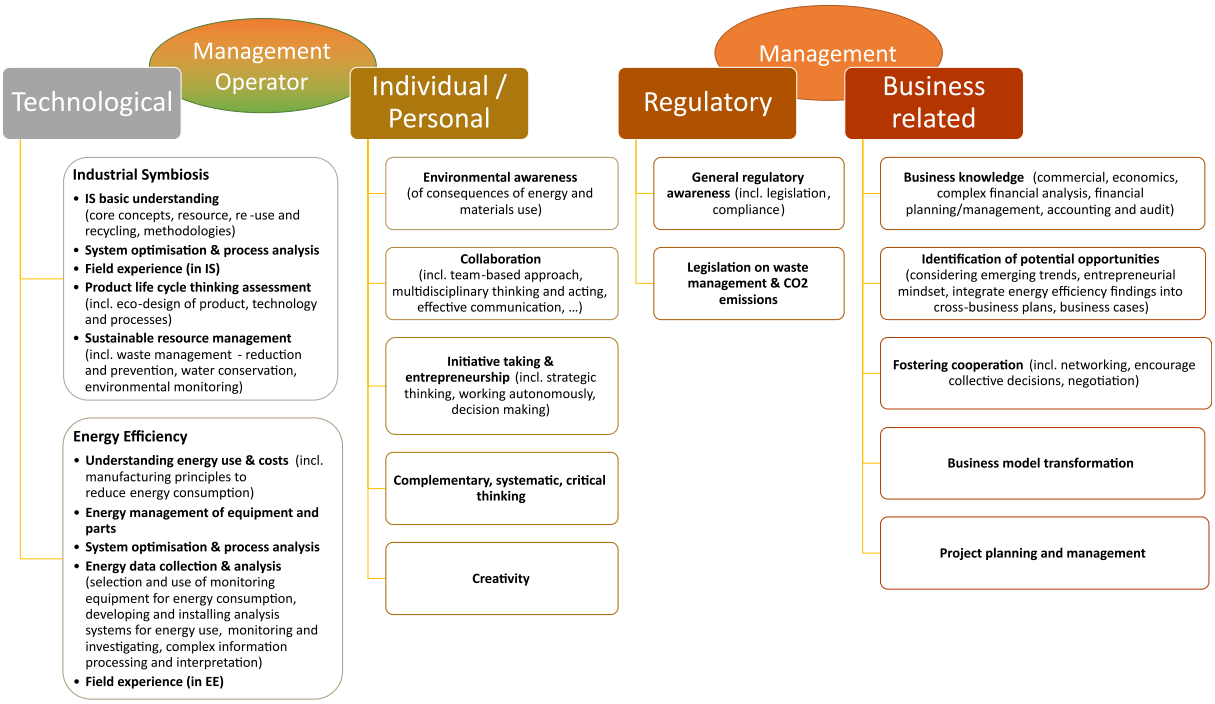


Figure 24: Skills and Competences Selection

Further steps were 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 was 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).

3.3.4 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, SPIRE-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 assessment** (Capability Assessor of SKILLS4Planet, chapter 5.3.2) is focusing on the specific job profiles and their related skills. The skills assessment is a checklist leading to a dedicated job profile assessment and description of the mission, the main tasks and related skills for these tasks. It is combined, with the related ESCO/ISCO occupation and equivalent profiles. The skills are 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: Skills Assessment Examples: Energy Manager and Liquid Waste Treatment Operator)
- Waste management technician (Liquid Waste Treatment Operator) (see Annex: Skills Assessment Examples: Energy Manager and Liquid Waste Treatment Operator)
- Maintenance and Repair Operator (refractory bricklayer) (see Figure 25)

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 25: 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 and proficiency levels in relation to the importance and priorities of the companies. Based on this evaluation the current skills level and Industrial Symbiosis Readiness Level of a company will be calculated.

3.3.5 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 are aligned as much as possible with relevant European tools. This ensures a continuous development and integration of the industry driven skills demands of EE and IS in existing and further to be developed formal occupations. Therefore, we integrated the ESCO/ISCO description within our Job Profile Description and Skills Assessment (see ISCO/ESCO code in Figure 25) and aligned the SPIRE-SAIS Job Profiles with the equivalent ESCO occupation (see Figure 26). 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 26: Alignment of Selected Job Profiles with ESCO Occupations

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

could be seen as a connecting link between industry demands and 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 Figure 27). Based on the selected SPIRE-SAIS functional job profiles (composed by a set of tasks) and the related skills (to perform these tasks), knowledge has to be identified that is required to gain those skills. Against this backdrop, learning objectives and outcomes including knowledge, skills and competence 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. a).

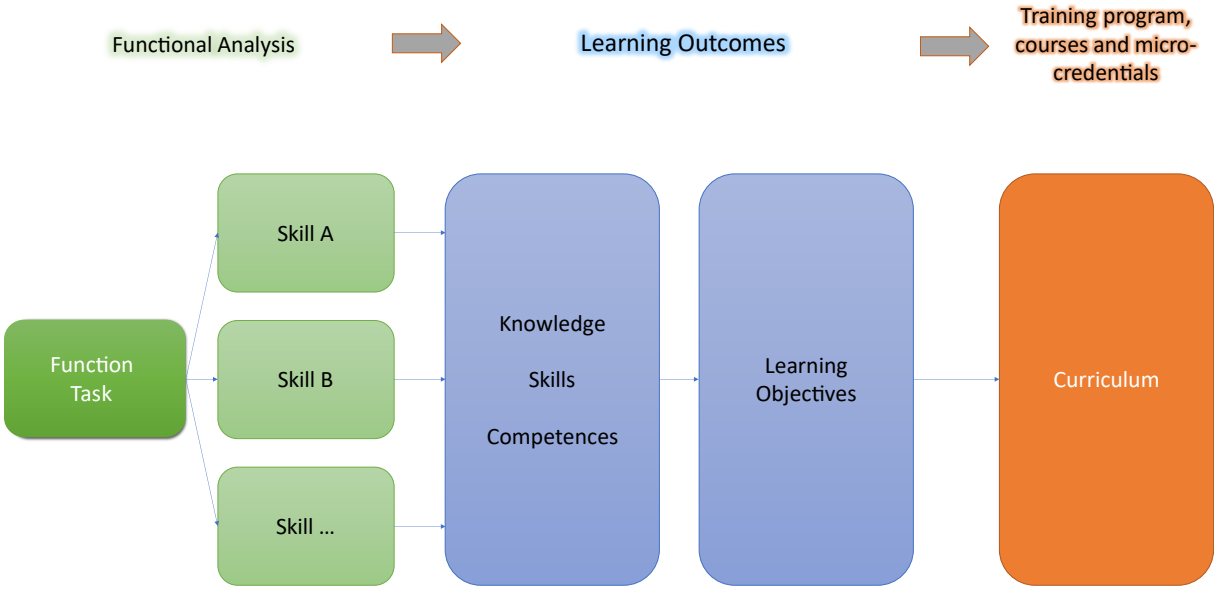


Figure 27: From Functional and Skills Analysis to Learning Outcomes

All these results are available in the framework of the SKILLS4Planet training platform, more about it in chapter 5.3.2.

3.4 Survey Results

An online survey with a total of 53 questions was conducted in the first half of 2024. It covered the topics of professional profiles, skills requirements and challenges in the energy-intensive sectors, aiming to give a quantitative overview of the state of these topics.

Figure 28 shows the structure of the survey: A question about the **type of organisation (1)** was followed by questions on the prominence and relevance of a selection of manager and operator **job profiles (2)**. Then, the **current and future skill requirements and changes of the requirements (3)** were surveyed. The questions were partly referring to the manager profile and partly to the operator profile with the highest relevance for Industrial Symbiosis and Energy Efficiency out of the perspective of the respondent. This section was followed by some

general questions on **organisational characteristics (4)**, before questions followed that addressed the **situation of the companies and the sectors more specifically (5)**. An **evaluation part (6)** concluded the survey.

A total of 27 participants were recruited for the survey. This relatively low number of participants correspond to general difficulties in recruiting survey participants, especially organisational representatives. Despite attempts to balance the scope of the survey and the interest in the findings, some of the participants criticised the amount of time required to complete the survey (see evaluation part below), which also may have contributed to the low number of participants.

The survey was aimed at representatives of different organisations. Thereby, the questions were always related to the context that the interviewee was able to oversee. For company representatives, this was their own company; for representatives of other organisations, it was the sectors they were familiar with.

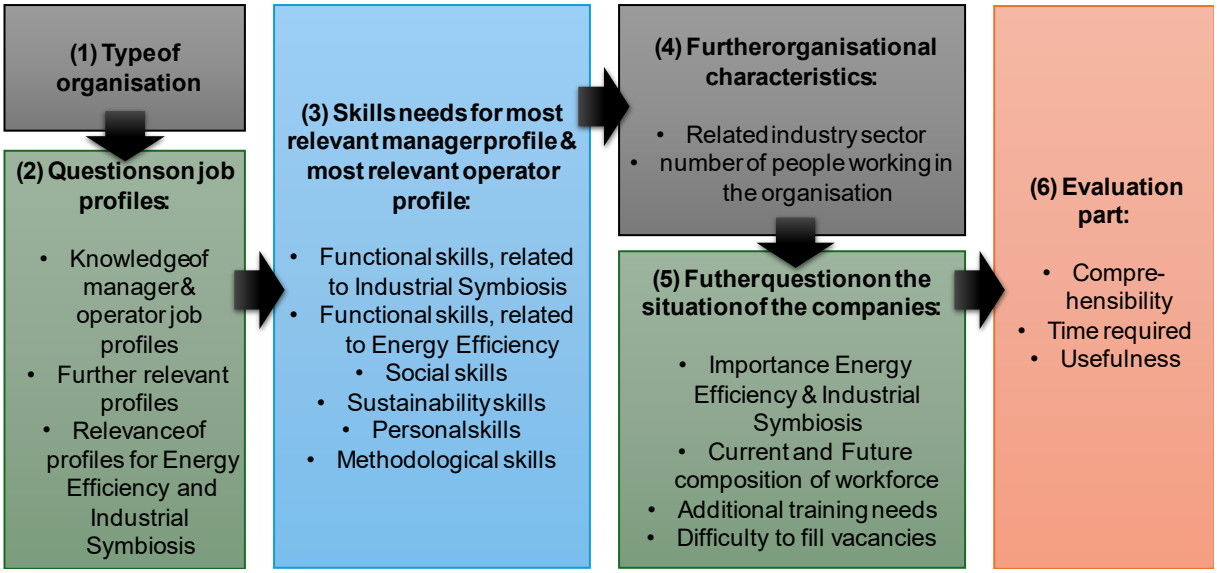


Figure 28: Structure of the questionnaire

Looking at the survey participants, most of them came from companies (16) but trade unions also played a certain role with 6 participants (see Figure 29). Among the companies, companies with more than 1,000 employees dominated (13). Two companies had 251-1000 employees and one company had 1-250 employees.

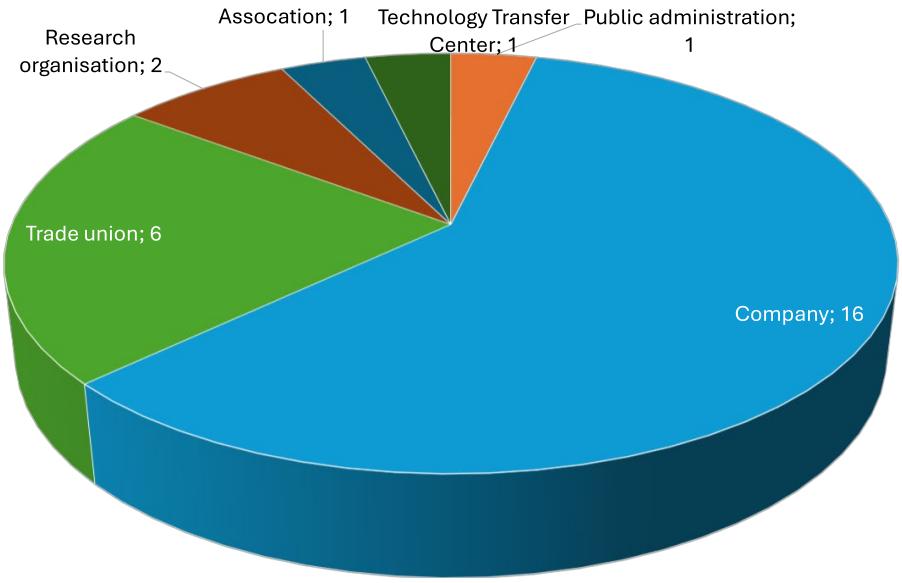


Figure 29: Type of organisation the participants are members of (n= 27)

Each of the sectors addressed in the SPIRE-SAIS project was covered by the sample, although to varying degrees (see Figure 30). Most of the respondents indicated a connection to the iron and steel sector (67 %), but the engineering, chemical and non-ferrous metals sectors were also well covered with a third of respondents for each item. The cement sector had the worst coverage in the sample.

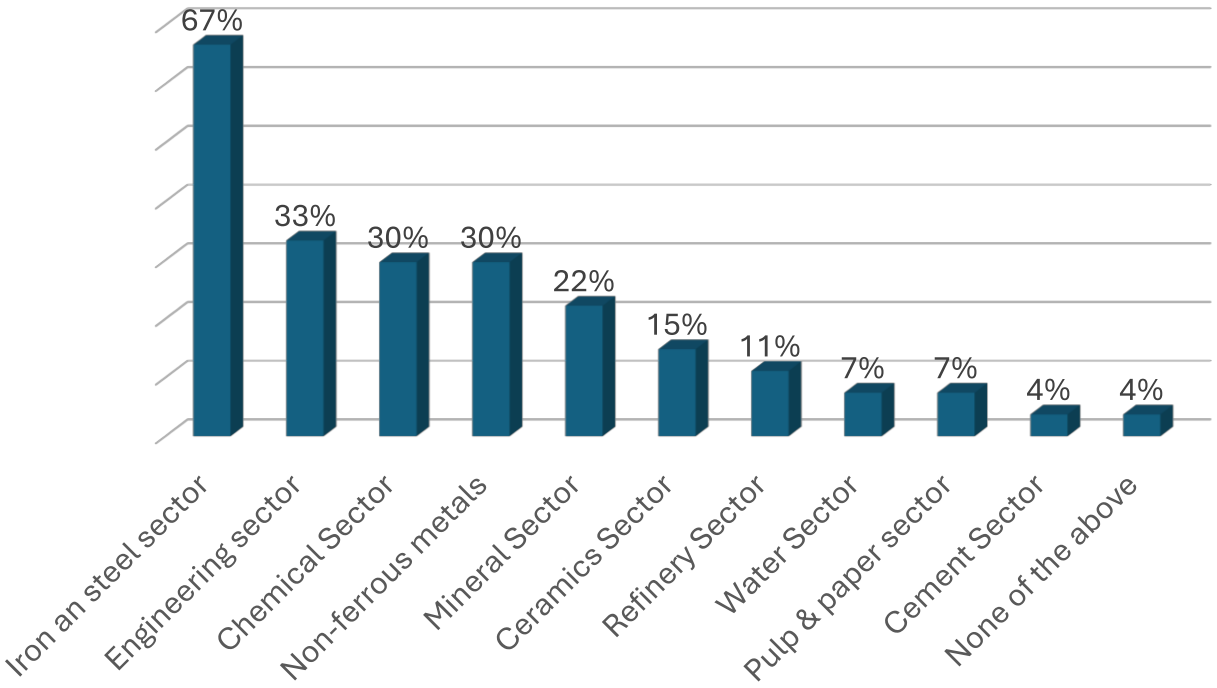


Figure 30: Represented Sectors in the sample (n=27, multiple answers possible)

3.4.1 Challenges of Energy Intensive Industries

According to the majority of survey participants, Energy Efficiency and Industrial Symbiosis play an important role for companies in energy-intensive industries. As Figure 31 shows, 4 out of 5 respondents state that Energy Efficiency is very important for the company or sector, while this also applies to Industrial Symbiosis for half of the respondents. Only very few respondents

(12% for Industrial Symbiosis, 8 % for Energy Efficiency) rated these topics as (very) unimportant.

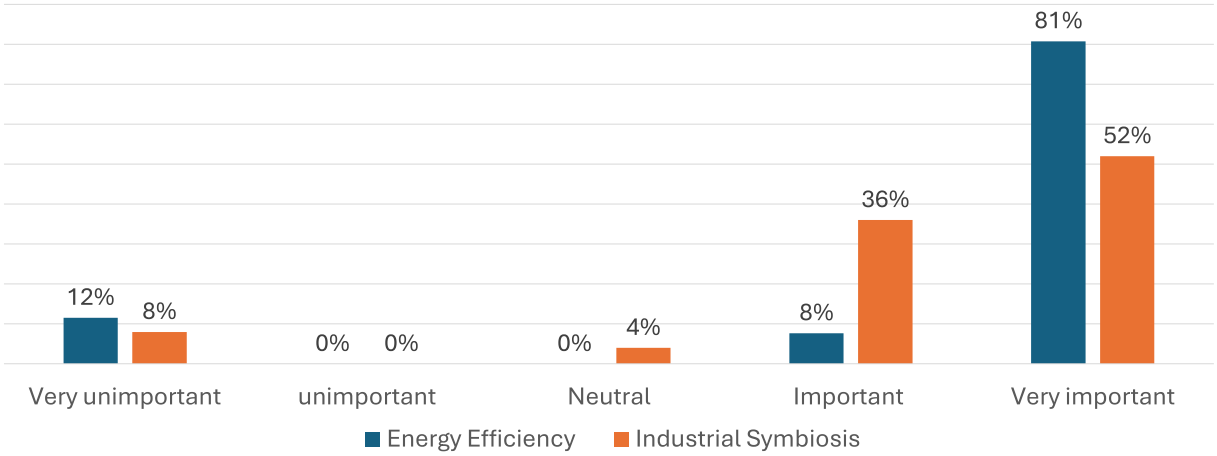


Figure 31: Importance of Energy efficiency and Industrial Symbiosis (n= 27)

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

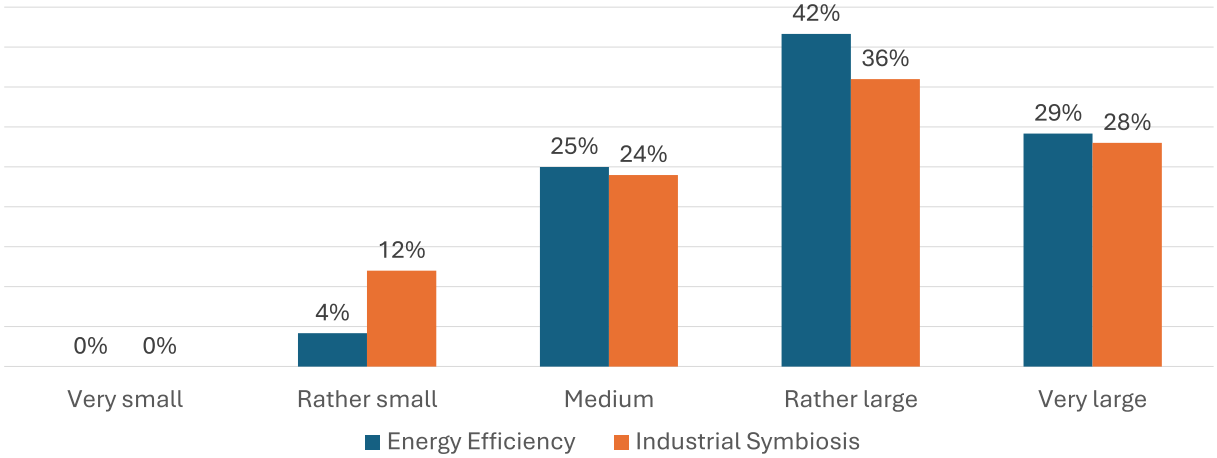


Figure 32: Need for training (n=24 for Energy Efficiency, n = 25 for Industrial Symbiosis)

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

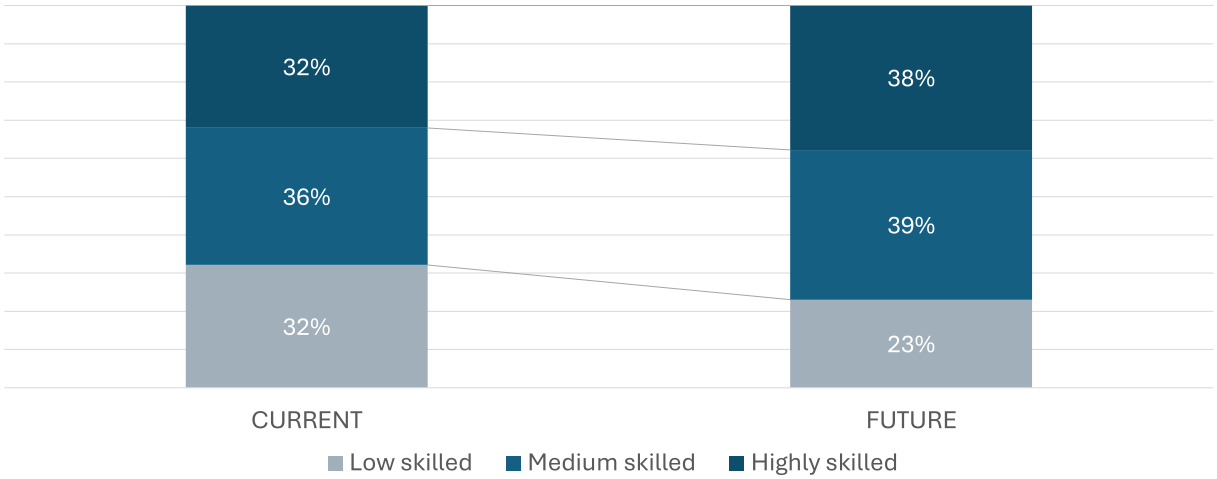


Figure 33: Current and future composition of workforce (n=24 for Current Composition, n=25 for Future Composition)

It is however unclear to what extent this change in company structures can and will be realised by filling new positions. Only one respondent stated that filling vacancies was easy, while around 3 out of 4 respondents rated the challenge of filling vacancies as difficult or even very difficult (see Figure 34).

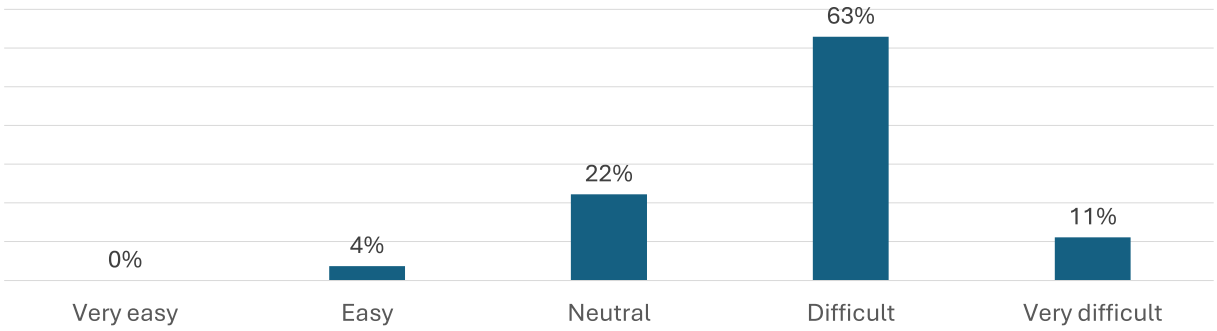


Figure 34: Difficulty to fill vacancies (n=27)

3.4.2 Job profile characteristics

The survey was also used to find out which manager and operator job profiles were known to the respondents from their everyday work, whether in a company or in another organisation with a connection to energy-intensive industries.

With regard to the manager profiles (see Figure 35), the Production Manager (81%) and the Materials / Product Manager (78%) were the best known profiles, followed by the HR Manager (74%) and the Quality and Maintenance Manager (70% each). The least known profile was the Waste Manager / Responsible with around one in two participants who knew the profile from their everyday work.

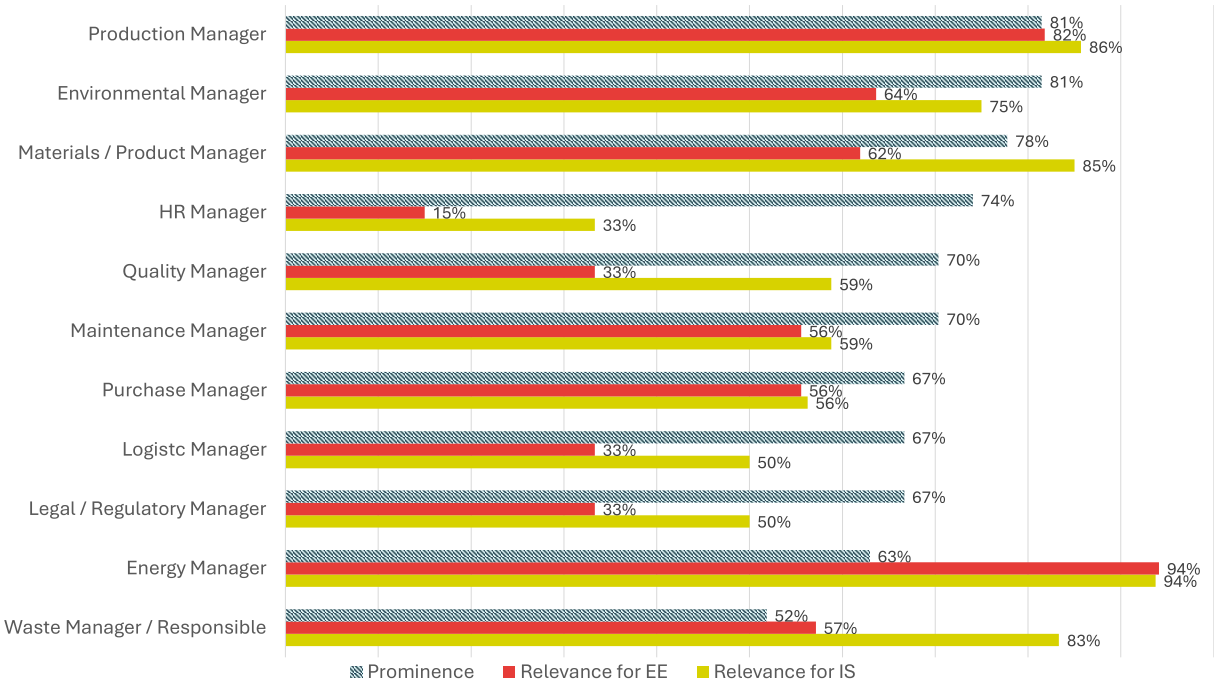


Figure 35: Prominence of Manager Profiles *(% of participants who know the profiles from their daily work) & their importance for EE and IS (% of participants who selected the upper two points in a 5-level scale). Respondents (n): n=27 (Prominence), n=14 to 22 (relevance to Energy Efficiency), n=12 to 21 (relevance to Industrial Symbiosis)*

For the operator profiles (see Figure 36, the Production / Processing Line Operator / Foreman Materials, the Maintenance / Repair Operator / Foreman and the Materials Operator / Foreman were in the foreground with 78 to 81 percent knowledge ratio for each profile (see Figure below). Similar to the managers, the Waste Management Technician was the least recognised profile among the operator profiles.

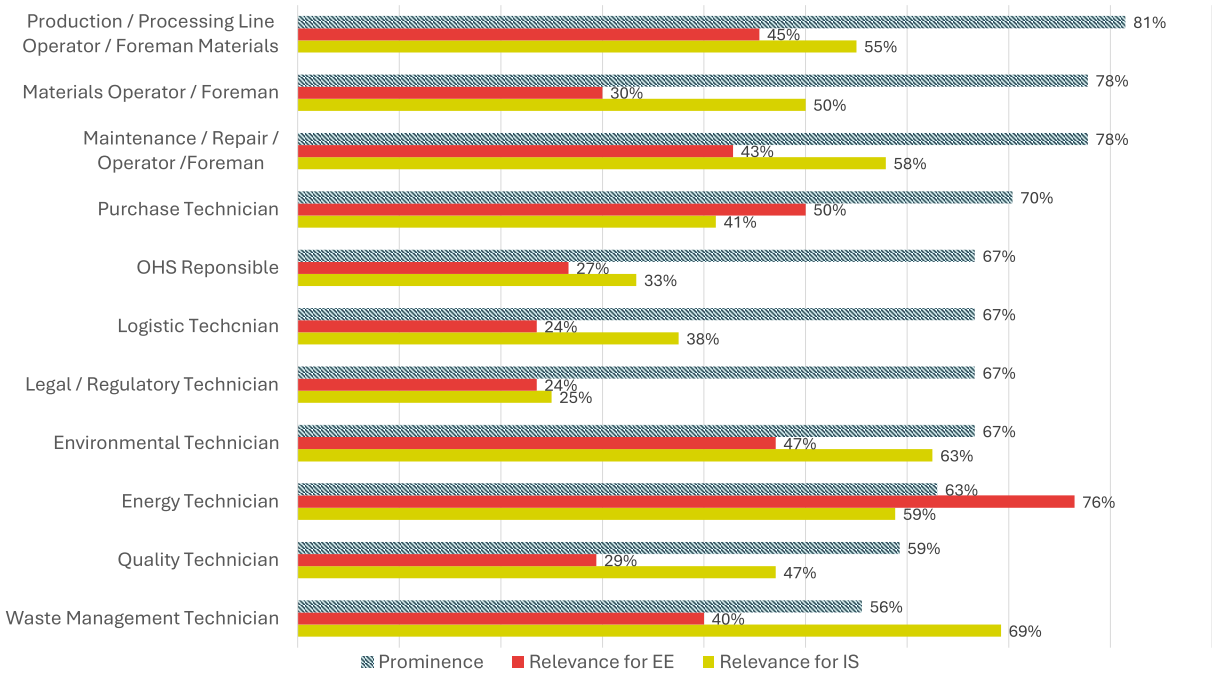


Figure 36: Prominence of operator profiles *(% of participants who know the profiles from their daily work) & their importance for EE and IS (% of participants who selected the upper two points in a 5-level scale). Respondents (n): n=27 (Prominence), n=15 to 22 (relevance to Energy Efficiency), n=13 to 20 (relevance to Industrial Symbiosis)*

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

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

The named profiles cover a wide range of areas, from sector-specific profiles (Wood Management, Agriculture) to overarching professional profiles (Financial Manager, Sales Manager), as well as profiles related to energy and sustainability (Energy Transition Manager, Energy Consumption Manager, Sustainability Leader).

As also shown in Figure 36 and Figure 37, the importance of the job profiles for Energy efficiency and Industrial Symbiosis was captured as well, if the profile was known to the participants. Thereby some insights stand out:

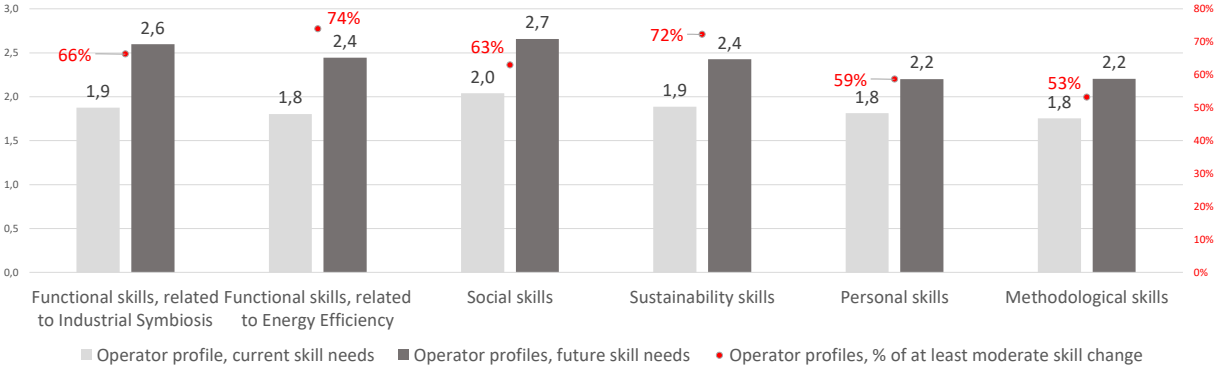
- On average, the Operator profiles receive slightly lower average scores in terms of their relevance for Energy Efficiency and Industrial Symbiosis
- The Energy Manager and Energy Technician profiles stand out, both of which have a high relevance for Industrial Symbiosis and Energy Efficiency – e.g. 94% of participants rated the Energy Manager with 4 and 5 on the 5-level scale (hereinafter referred to as importance ratio)
- Similarly, the importance ratios of the Waste Manager and Waste Technician, Production Manager, Environmental Manager and Materials / Product Manager profiles is relatively high compared to their general prominence to the participants
- Overall, the most important profiles in terms of Energy Efficiency are Energy Manager (94%), Production Manager (82%) and Energy Technician (76%), while Energy Manager (94%), Production Manager (86%) and Materials and Product Manager (85%) are in the lead in terms of Industrial Symbiosis
- Profiles such as Human resources manager or Legal / Regulatory technician are only of minor importance for Industrial Symbiosis and Energy Efficiency (15 % / 33 % respectively 24 % / 25 % importance ratio).

3.4.3 Skill needs of job profiles

The skill requirements were captured using an system skill categories as well as skill levels developed within the SPIRE-SAIS project (see 3.3.4). Thereby, each broad skill category is composed out of several skill sub-categories.

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

When looking at the development of skill requirements for manager and operator profiles (see Figure 37 and Figure 38), it is noticeable that the range of skill levels required is currently at a relatively similar level (2.6 to 2.9 for manager profiles, 1.8 to 2.0 for operator profiles), but in the future not only higher skill levels will be required overall, but also a higher range with higher differences is diagnosed by the participants (2.8 to 3.3 for manager profiles, 2.2 to 2.7 for operator profiles).



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

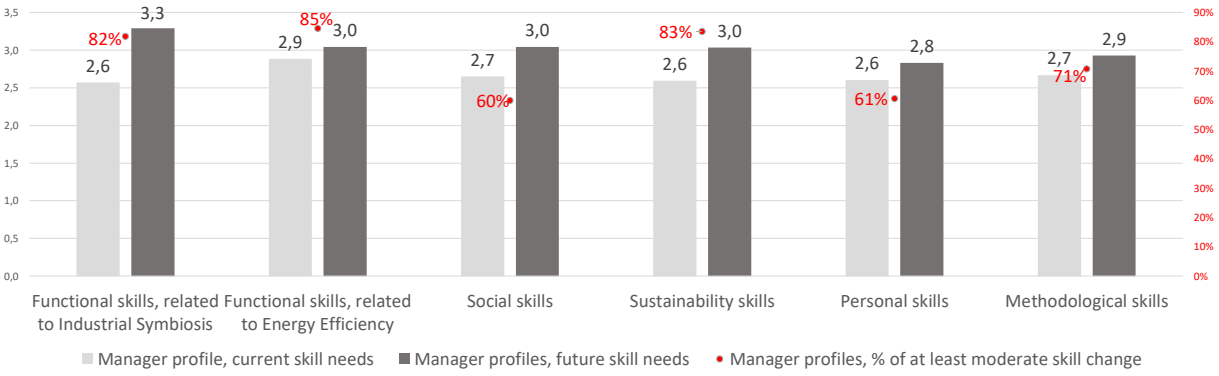


Figure 37: Development of manager profile skill needs (n= 24-26) (*Level 0: Novice, Level 1 - Awareness / Basic Actor, Level 2 – Practioner, Level 3 – Expert, Level 4 – Master)*

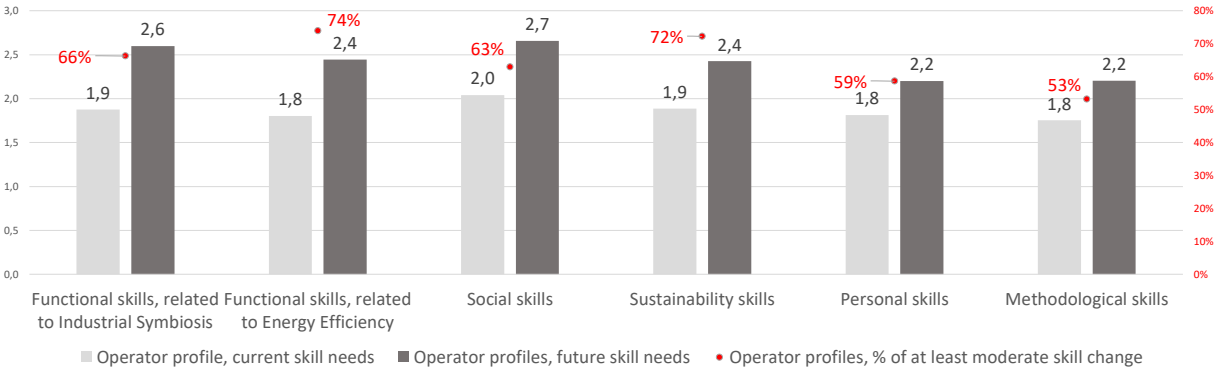


Figure 38: Development of operator profile skill needs (n= 23-25) *(Level 0: Novice, Level 1 - Awareness / Basic Actor, Level 2 – Practioner, Level 3 – Expert, Level 4 – Master)*

3.4.4 Evaluation of the Questionnaire

For the evaluation of the questionnaire the comprehension ability, the required time as well as the usefulness of the questionnaire was tested.

Regarding the **comprehension** the biggest problems seem to occur in the assessment of the current and future skill levels (see Figure 39) around one in three participants disagreed with the statement they had no problems evaluating the future skill levels where as one in three participants showed problems with regard to the current skill levels.

This suggests that the ability to abstract from experience from the energy-efficient industries to numerical information on a numerical scale of skill level is a challenge, especially with the regard to future scenarios. However, it seems to be difficult to avoid if one wants to determine skill requirements in the form of a survey.

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

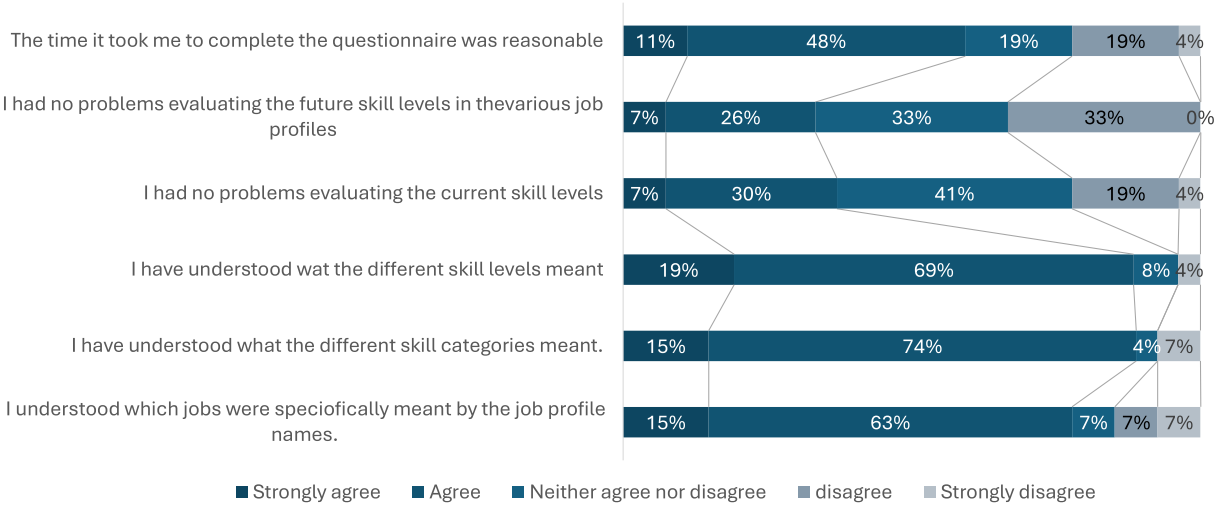


Figure 39: Disagreement and agreement to statements for evaluation (n = 27)

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

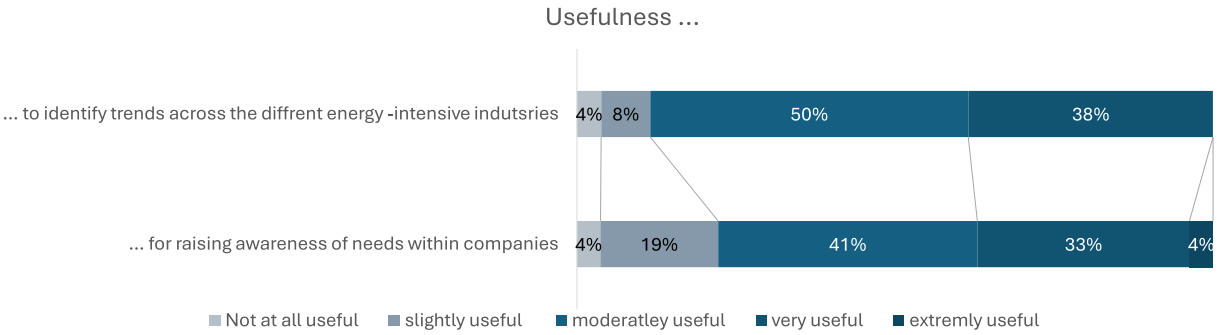


Figure 40: Usefulness of the survey (n=27 for raising awareness, n=26 for identify trends)

3.5 Summary

Based on the results of the technological development and related skills demands (WP2) a methodology for identifying and classifying skills was developed, starting with Facts & Figures and organisational flowcharts of six of the involved sectors. Against this backdrop, job profiles related to Industrial Symbiosis, Energy Efficiency, or both (including both intermediate management levels and blue-collar profiles) were identified, out of which 22 generic ones were selected across the sectors. A first selection of 65 related skills was prioritised, condensed and classified to a set of 22 skills. The selected 22 generic job profiles were interlinked with 22 related ESCO occupations.

In order to achieve the described goals and to deliver a sound input for the Blueprint, skills needs (current and future) in term of four proficiency levels and learning outcomes were defined, redefining professional profiles. Via the Learning Outcome Pipeline Methodology, a cohesive and structured link between industry requirements and educational formal occupations was established.

In a survey 2024 the selected job profiles and skills classification were endorsed. Additionally, the evaluation of the survey led to useful information how to setup the planned skills intelligence tool “Technology and Skills Radar”.

4 VET Systems Requirements (WP4)

Based on the technological and economic scenarios (chapter 1.2, WP2) and informed by the industry skills demands (chapter 3, WP3), the VET system analysis explores the possible and necessary contributions of the different systems in the member states, focusing specifically on three case study countries (Germany, Italy, Portugal), but commenting more widely with regard to regional patterns of skill formation.

4.1 Objectives

This work-package identifies how Vocational Education and Training (VET) systems and frameworks at national and EU level currently deliver skills concerning Industrial Symbiosis (IS) and Energy Efficiency (EE) of the Energy Intensive Industry (EII) sectors involved. It also identifies where non-formal company level VET attempts to close skills gaps in formal (state) provision. Hence, it addresses questions related to skill needs (WP3) and technological development (WP2) within VET provision serving the energy intensive industries. The overall activities of the WP will establish the reference points and main mechanisms for, and barriers to, skills/ training delivery in the European Energy Intensive Industries and thus provide a central aspect of the Blueprint delivery.

Against this backdrop, the following tasks are done:

- **Mapping of current VET provision for Industrial Symbiosis and Energy Efficiency skills** of the EIIs sectors in selected countries: VET mechanisms and programmes (frameworks) that serve the European EIIs at the national level are identified, reflecting different systems across Europe, identifying how European frameworks (e.g. EQAVET, ECTS, EQF, etc.) currently serve the industries.
- **Development of a cross-sectoral skills framework / matrix** across the European SPIRE industries and their relevant occupations, to: (1) establish national VET benchmarks for current cross-sectoral skills provision for occupations critical to the industries; (2) utilise data from WP2 and WP3 to strategize for meeting future skill needs through national VET provision and; (3) where appropriate correlate occupation skill-sets with European standards frameworks; giving answers to deficits in national VET systems and exploit available European resources to meet sectors skill needs.
- **Development of mechanisms for application of European VET framework** for cross-sectoral skills of EIIs: elaborating appropriate mechanisms for application of the cross-sectoral skills framework/ matrix. The main task was to develop the strategy and rollout for applying the European cross-sectoral competences framework/matrix in all SPIRE sectors and to encourage, as far as possible, its adoption in national VET systems. To this end, the Qualifications section has been included in the SKILLS4PLANET platform, with open and free access for anyone to consult the VET offers in each pilot country. In this section, it is possible to understand the national gaps in terms of VET offers for the skills required in the respective professional profiles.

4.2 Methodology

The described tasks were implemented in a way that ensures a) the best balance between the depth and breadth of the analysis and b) effective use of synergies between different WPs (esp. WP3 and WP4). Key principles of the methodological approach are as follows:

- The list of the IS and EE relevant green skills assessed in the WP4 were from the long list of skills relevant for the IS and EE that has been developed in the WP3 (based on the desk research and survey of EIIs representatives).
- There is a large number of occupations that could be described as relevant for the IS and EE. However, detailed assessment of the green skills provision in formal VET programmes for these occupations is not possible because of the divers and fragmented VET systems across Europe and the limited resources of the project. Thus, WP4 will assess the formal VET provision for a limited number of occupations. These occupations were chosen for the detailed assessment because they met the two key criteria defined: a) they were recognised as the central occupations contributing to IS and EE by industry representatives; b) they are transversal or cross-sectoral in nature (i.e. the same occupation must have a similar equivalent in the different industry sectors). The occupations selected were Energy Manager, Energy Technician, Waste Manager and Waste Technician. The work done under T4.3 of WP4, these job profiles (i.e. occupations) were linked with the respective formal VET programmes and qualifications in each country.
- WP4 combined generalised and in-depth analysis of the relevant skills provision. The results of the interviews and answers to the questionnaires carried out on WP3, and the analysis of national VET programmes identified the overall trends concerning EE and IS relevant green skills provision in a particular country. However, this approach was not sufficient to describe specific practices or to identify what skills are addressed the most successfully. Thus, in parallel with the generalised analysis WP4 focused on the analysis of skills' provision in the limited number of VET institutions. The analysis of specific curricula in each country, assesses how IS and EE relevant green skills are provided in the selected VET institutions.

Principles of the methodological approach		
Limited number of skills: EE and IS relevant green skills	Limited number of occupations/ VET programmes	Limited number of formal VET institutions

Table 3: Principles of the methodological approach

To achieve the objectives of the VET system analysis desk research, online surveys, interviews, and a selection of VET system countries were planned. However, not all the expected actions were carried out.

4.2.1 Desk research

The desk research included the analysis of different types of sources (available):

- National policy documents (strategies, legal acts, reforms): to identify and describe policies regulating and facilitating provision of the EE and IS relevant green skills. More particularly, we aimed to answer a) how IS and EE related green skills are mentioned

in relevant VET/educational policies b) how skills and education is mentioned in policies relevant for IS and EE.
- Key features of VET systems in selected countries.
- Other national level research and studies analysing the provision of (EE and IS relevant) green skills by formal VET system in a particular country.
- Documents of VET institutions selected for the detailed analysis (e.g. curricula of relevant programmes).

4.2.2 Online survey

WP4 intended to share a questionnaire with VET institutions to assess the current situation of formal provision of EE and IS green skills, identifying the main obstacles and drivers and cases of good practice applied in their own institutions. This questionnaire was going to be part of the rollout strategy to disseminate the platform and ask for these inputs from stakeholders, however, with the successive delays in accessing the platform and uploading all the content, it was no longer possible to carry out this task.

4.2.3 Interviews

WP4 conducted in-depth interviews with the following four groups of respondents:

a) Interviews with experts of the EE and IS to obtain assessment of the overall situation concerning green skills delivery in formal VET programmes, and to identify best practices or relevant national policies.
b) Interviews with representatives of institutions responsible for the administration of VET on the national or regional level to understand relations between the VET and representatives of the EII in the country, as well as to hear VET representatives' perceptions about the green skills integration in the VET programmes (e.g. key challenges and drivers).
c) Interviews with representatives of selected VET institutions (teachers and representatives of administration) for a more in-depth analysis of green skills provision on the formal VET level.
d) Interviews with representatives of selected specific good practice examples (e.g. projects, policy measures) to develop case studies (see this section below).

4.2.4 Selection of countries

Three EU countries were chosen representing different VET systems: Germany, Italy, and Portugal. The selection is based on the following reasons:

- EII play an important role in the economy of all selected countries.
- Partners representing these countries are involved in the SPIRE-SAIS project. It guarantees that the analysis is complemented by the in-depth knowledge of the national context. Moreover, knowing of the national language is beneficial for the research.
- Countries cover different types of VET systems:
    - Apprenticeship-based, dual VET system – Germany
    - Regional general VET education – Italy
- Centralised school-based VET – Portugal
- Countries cover different EU regions:
    - Western-Central Europe – Germany

- Southern Europe – Italy, Portugal

4.3 Results

The VET system review for skills demands on Industrial Symbiosis and Energy Efficiency was reflected VET systems in three countries, representing different VET structures: Germany, Italy, and Portugal (for the detailed analysis and summary of the VET system in these countries see SPIRE-SAIS, Deliverable 4.1 (Visionary Analytics, 2024b)). Through this analysis, good case studies are additionally gathered in a repository (see recent status in the Annex of Deliverable 5.1 (Muract et al., 2024)). A selection of them is illustrating the provision of skills relevant for IS and EE in this chapter. Additionally, the cross-sectoral skills' matrix database with components and functions, was created and fulfilled with the national information collected for 4 job profiles (Energy Manager, Energy Technician, Waste Manager and Waste Technician). The conclusion was that the EE and IS related skills offered in these VET systems is far from the current needs to EIIs. Some of the qualifications offer, partly, the skills identified however the vast majority are not even mentioned in the description of the qualification or on the qualification programme. Therefore, it is urgent and necessary to create training content that responds to the needs of the sectors explored in the SPIRE-SAIS project.

4.3.1 Key Features of VET Systems

Comparing the three analysed VET systems by some key elements for an integration of SPIRE-SAIS industry skills requirements (as summarised in Table 4), 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 (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[2]. 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.

[2] 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).

- **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) than in historically school-based systems (Italy, Portugal).

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

Table 4: Overview of Selected VET Systems

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

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

Except for Germany's 'National Action Plan for Sustainable Development in Education' (National Platform on Education for Sustainable Development, 2019), no specific strategies for green skills delivery have been identified in the target countries. Broader national educational strategies rarely explicitly mention green skills[3], 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.

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

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 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.

Table 5: Good Practices of IS- and EE-related Skills Provision: Policy Level

4.3.3 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 Germany, and Portugal also offer a good number of dedicated courses.
- 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 in the first study carried out. Fortunately, the Emilia-Romagna region in Italy already has a qualification of Junior Technician for the Circular Economy and Industrial Symbiosis however is the only country that have work developed in the IS field.

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.

'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.
In Portugal, ***'Network of Coordinator Teachers of Environmental Education Projects'*** promotes environmental education. The Network has contributed to the promotion of various initiatives, recognition of projects, inclusion of content in school curricula and the creation of a network of teachers with technical-pedagogical skills for the coordination and promotion of projects in communities, developed with environmental NGOs.

Table 6: Good Practices of IS- and EE-related Skills Provision: Implementation Level

International/EU context

In most countries, a significant share of green skills training is being delivered outside formal VET, as project-based, ad-hoc activities. The role of international stakeholders in this area is important – firstly, many successful initiatives are delivered internationally or with the support of international stakeholders[4]. 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.

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.

Table 7: Good Practice of IS- and EE-related Skills Provision: International Dimension

[4] 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.

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

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

- **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.

4.3.5 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 elaborated 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 was digitalised to the project platform (SKILLS4Planet) and, since it is freely accessible to any individual, 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 can know what qualifications are directly linked to this job profile. Moreover, the matrix identifies the relevant national qualifications that exist in different countries. Therefore, it is easier for representatives of the industry know whether qualification acquired by a candidate in a foreign country is relevant for the position (job profile) they need to fill. This will facilitate international mobility of employees.

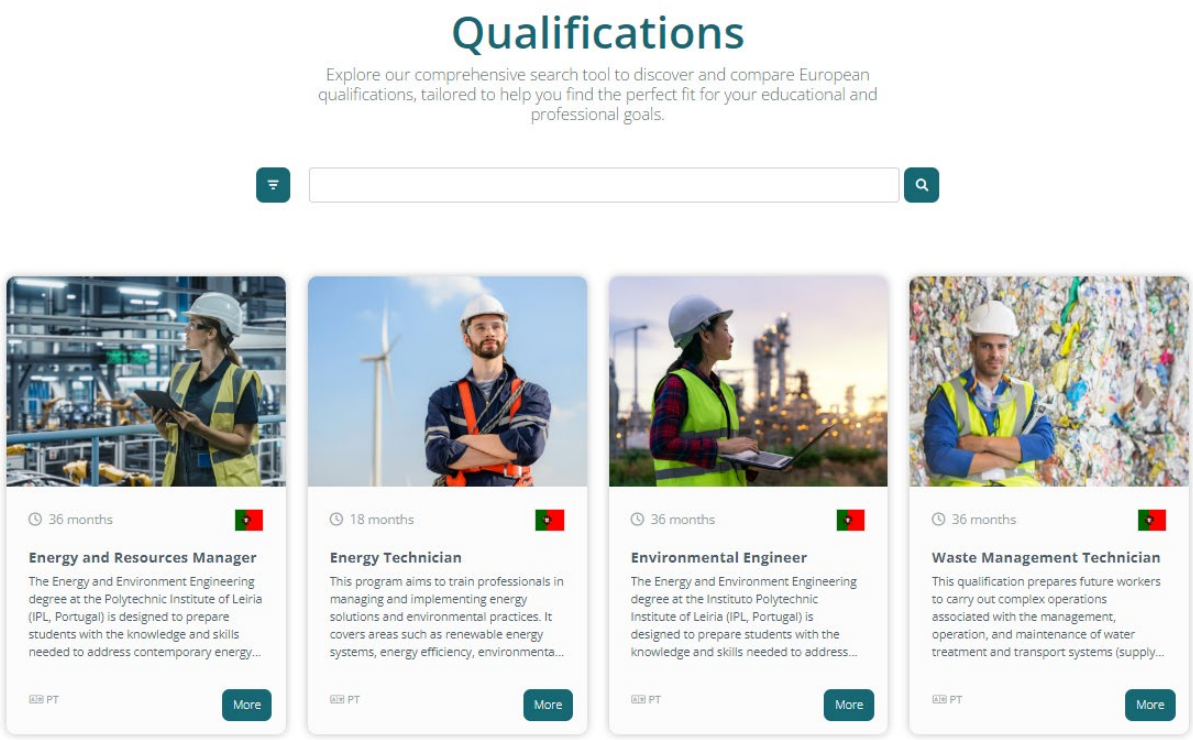


Figure 41: Database of Occupations across the Pilot Countries (Matrix Example EU – Portugal) in the Qualifications Section of SKILLS4PLANET

4.4 Summary

Mapping of current VET provision for Industrial Symbiosis and Energy Efficiency skills of the Energy Intensive Industry sectors took place in five selected member states: Germany, Spain, Italy, Poland, and Portugal. 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 fragmentation of the responsibility for green skills delivery and a missing overarching strategy, while funding tends to be fragmented and short-term as well.

With a combined matrix of cross-sectoral Industrial Symbiosis and Energy Efficiency skills, SPIRE-SAIS tends to “connect” different concepts including job profiles, occupations, and qualifications and to identify how Industrial Symbiosis and Energy Efficiency related skills needs are addressed in relevant VET programmes. The therefore developed matrix is combining the industry job profile perspective with (formal) qualifications of the VET system, aligned with European programs like ESCO and EQF. It maps the highlighted job profiles (Energy Manager, Energy Technician, Waste Manager, and Waste Technician) and skills relevant to IS and EE, aligning them with EU frameworks and assessing their integration into national VET systems (Italy, Germany and Portugal). The matrix was integrated into the SKILLS4Planet online platform. It includes a Learning Solutions Directory, Skills Directory, and Qualifications Section, providing educational resources and detailed qualifications for the Energy Intensive Industries (EIIs). It helps align industry needs with VET provisions and facilitates international employee mobility. The work done on national EQF qualifications related to IS and EE, emphasised the need for continuous updates of the platform, regarding qualifications, profiles, and training courses to maintain a relevant and effective skills framework.

5 European Blueprint Development (WP5)

The European Blueprint development is based on the results and inputs of the technological and economic developments, their impact on the companies' skills requirements and VET systems provisions. The Blueprint summarises and integrates these results in a practical, user friendly orientation, information, and support framework: **developed with the Energy Intensive Industries for these industries**.

5.1 Objectives

The main objective of the project is to develop a Blueprint for a European Intensive Industries Skills Agenda and Strategy (SPIRE-SAIS) for an ongoing and short-termed implementation of new skills demands. This was piloted by the development of related scenarios, strategies, training modules and tools, and new training methods and arrangements: assessment, strategies and measures to anticipate and secure a skilled workforce needed for a global competitive industry, ready to anticipate new skills demands and to allow pro-active practical activities that meet the future requirements of the industry.

Main objective of the work package is to develop an *industry driven pro-active skills strategy* that reflects the (recent and anticipated) technological and economic strands and builds on the upcoming technological and economic developments (chapter 1.2, WP2), the results and requirements of the companies (chapter 3, WP3) and their integration in the VET systems (chapter 4, WP4).

The Blueprint is focused on the general objectives of the SPIRE-SAIS project (as described in chapter 1.2.2): identifying skills demand of the industry, proposing training and curricula requirements, improving and updating training and successful sectoral upskilling schemes, and not to forget, improving the image and attractiveness of the Energy Intensive Industries for talented people (recruitment and retention).

The results of these objectives lead to a comprehensive Blueprint. This work package serves as an input and basis for the implementation and transfer of the Blueprint and the policy recommendations and dissemination activities (chapter 6 and chapter 7, WP6 and WP7).

5.2 Methodology

Based on the results of the entire activities, an integrative development, design, implementation, piloting of the industry driven European Blueprint and concepts for a rollout to the sectoral, national, regional and company level are in place. Due to the iterative cyclical concept of SPIRE-SAIS, a Prototype was elaborated in 2022, piloted and tested and followed by an upgrade and finalisation of the Blueprint in 2024.

Assessment of the Blueprint and implementation of the established European Skills Alliance for Industrial Symbiosis (SAIS) are part of the dissemination, exploitation, and rollout activities (WP6/WP7). This includes feedback and improvement by the sector associations and social partners as well as by the Advisory and Programming Group APG of the new SPIRE Processes4Planet program (strategizing for necessary political support measures and the means for mobilising and integrating stakeholders and policy makers of the EU and national level to meet Blueprint aims and objectives).

Against this background, the following tasks are conducted collaborative with divided responsibilities due to the expertise and preferences of the involved companies and training providers:

- **Strategy** development for the implementation of measures to meet defined skill needs (in accordance with WP2, 3 and 4):
    - building on the sector skills framework and improvement of sector occupations and job profiles
    - defining, revising and creating new and upgraded occupational profiles – to fit with emerging and diminishing skill needs
    - preparation of the ground for the identification of tools and upskilling schemes, training courses, tools and activities.
- Identifying successful **cross-sectoral upskilling schemes**, including the exchange of existing tools and best practice (e.g. on national occupational standards), as well as the efficient management of knowledge on skills and qualifications for the sector
- Development of **training courses, tools and activities** for integration within VET at national and sector level as well as in company and association training programmes (incl. interrelation to existing EU tools like EQF, ESCO, etc.). This central Blueprint task included the development of
    (a) training courses for up- and reskilling existing profiles,
    (b) new occupational profiles or parts of it,
    (c) new leadership and work 4.0,
    (d) train the trainer, improve the training providers,
    (e) new training methods and arrangements, considering new possibilities of digital learning and support (social media, Moodle, virtual labs, online learning, …) and workers participation (e.g. workplace innovation, and using digital tools like tablets, smart phones, laptops, etc.).
- Development of strategies to overcome central **human resources challenges** of the Intensive Industries, improving the attractiveness of the Intensive Industries and careers for talented people (recruitment and retention), overcoming recruitment difficulties and widening the talent pool for a more diverse workforce (with knowledge of cross-sectorial needs and opportunities for cooperation) as well as strategies increasing the workforce mobility and diversity (e.g. increasing the attractiveness of the Intensive Industries for women).

Assessment of the Blueprint and implementation of the related established European Intensive Industries Skills Alliance (SPIRE-SAIS) was done in WP 6 and 7. This includes feedback and improvement by the intensive industries companies, associations, social partners, training providers, research and education organisations, and other stakeholders, evaluated during the project life span and beyond.

Quality and Evaluation (WP8) are key elements of the SPIRE-SAIS project assuring an alignment with the EQAVET quality cycle and indicators, and accompanying the project activities and progress throughout its duration. It also includes Responsible Research and Innovation (RRI) (see D8.3; Almeida, 2023) in order to promote a proactive strand and diffusion of more advanced governance settings (including cross-cutting organisational practices, tools, arrangements and culture) capable to create an environment enabling RRI in the project since the beginning.

In practice, we consider the following six key components of the RRI framework:

- **Public and societal engagement** (aiming to broadly engage society in research and innovation activities)
- **Open access** (aiming to increase access to scientific results)
- **Gender equality** (aiming to ensure gender equality, in both research process and research contents)
- **Ethics** (aiming at embedding the ethical dimension in research and innovation)
- **Science education** (aiming at enhancing formal and informal science education inside research institutions and in the society at large)
- **Governance** (aiming to develop governance models for RRI capable to integrate the other five keys)

As a side and added value task, it's also a goal in the SPIRE-SAIS project to bring together the real needs and challenges of society, being Industrial Symbiosis of major importance to face the challenge of sustainability and economic competitiveness of the industrial sectors covered by this project. It is of outmost importance to consider the view of all the actors included in the "Quadruple Helix" approach (academia, industry, government and society) to guarantee a greater uptake of Industrial Symbiosis by them all.

5.3 Results

Against the continuous observation of the (1) technological, economic, and societal demands and the related skills requirements and adjustment needs (2), strategies and measures are developed (3) supported and taken up by new or existing alliances and leadership (4) and implemented and rolled out on the European, sectoral, national, and regional level (5) (see Figure 42, already summarising also the main elements of these overarching and interrelated topics).

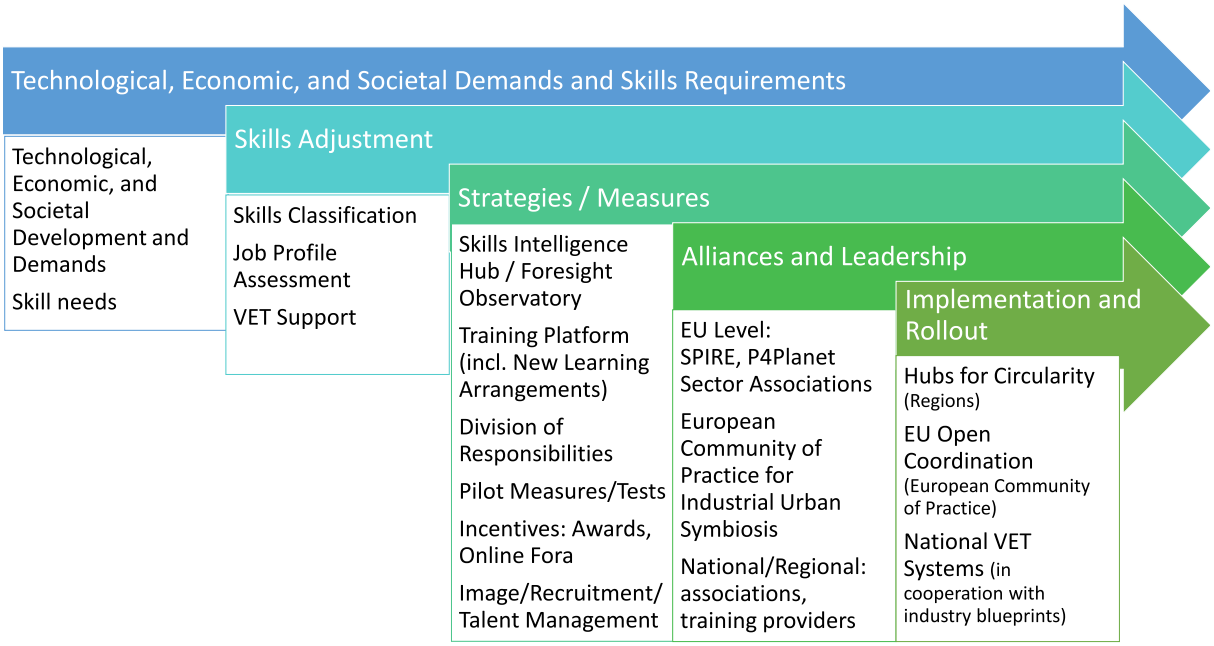


Figure 42: Outline of the SPIRE-SAIS Blueprint

The SPIRE-SAIS Blueprint is answering the industry skills demands with the establishment of Skills Intelligence via a **Foresight Observatory.** An **Online Training Platform,**

SKILLS4Planet, and a to be established **European Training Community for Industrial Symbiosis** supported by **Image and Recruitment** concepts are further central elements.

This includes the demand, supply and coordination of the Blueprint.

The **demand side**:

- Observing continuously (within an annual period) the *technological and economic demands and its related skills requirements*
- Ensuring an industry driven and defined skills adjustment by a generic *skills and central job profiles classification*
- Aligned to existing *VET system occupations* as much as possible

The **supply side**:

- Setting-up *strategies and measures* to ensure proactive and sustainable skills adjustments across and in the different industry sectors by:
    - Establishing a Foresight Observatory and Survey (Industrial Symbiosis Technology and Skills Radar) (section 5.3.1)
    - Creating a training platform for (new) training offers and appropriate learning arrangements (see D5.1;Muract et al., 2024), including (section 5.3.2):
        a) An interactive and open online training platform of training courses for Industrial Symbiosis and related Energy Efficiency
        b) possibilities for pilot measures and tests (by taking advantage of European and national/regional funding opportunities: Horizon Europe, Processes4Planet, Erasmus+, ESF+, EFRE, Pact for Skills, and others)
        c) incentives and/or awards for generating good/best practice
    - Initiating and fostering image, recruitment, talent management strategies and campaigns to attract more (young) people for the process industry (section 5.3.3)

The **coordination side**:

- To sustainably run the Blueprint, *new alliances and governance structures* (chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**) 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 (e.g. Hubs for Circularity). This leads 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 established a close cooperation with the European Community of Practice for Industrial Symbiosis and Hubs for Circularity (ECoP H4C), 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 Intelligence, and others).
  The rollout of the Blueprint so far (see chapter 6) was concentrating on sector associations and two regions part of SPIRE-SAIS, including VET system players of Member States. Further rollout will be done in a common action with the Pact for Skills (Large

Scale Partnership Energy Intensive Industries (LSP EII)) and other sectoral industry Blueprints (batteries, hydrogen, steel, automotive, construction, digital, and others), as far as this is feasible and possible.

Against this overview of the main elements supplying and coordinating the skills adjustment for Industrial Symbiosis and Energy Efficiency the central constituents of the Blueprint will be outlined in detail:

- Skills Intelligence and Foresight Observatory
- Training Framework and SKILLS4Planet online training platform
- Image and Recruiting
- European Coordination.

5.3.1 Skills Intelligence 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. Therefore, we will establish a **Foresight Observatory** as the core coordination unit of SPIRE-SAIS within these elements:

- Technology and skills foresight will be done within a **Foresight Observatory** on a regular basis, e.g. via an annual survey "**Industrial Symbiosis Technology and Skills Radar**".
- Technological and economic development and skills related projects will be listed in a **Project Repository**, continuously updated.
- Recommendations, self-assessment tools, indicators and incentives will push the focus on qualifications, competences and skills for Industrial Symbiosis and Energy Efficiency.
- Pilot measures and test options for IS and EE skills adjustments will be supported and fostered, including looking for (European and national) funding schemes.
- The **Online Training Platform, SKILLS4Planet,** gives immediate answers to the industry skills demands (see in detail section 5.3.2).
- Industry image campaigns for **recruitment and talent attraction** will be supported focusing on IS / EE skills and qualifications (see in detail section 5.3.3).
- Leadership will be defined in an Open Coordination way, dividing responsibilities between the main and willing actors (see in detail section **Fehler! Verweisquelle konnte nicht gefunden werden.**).

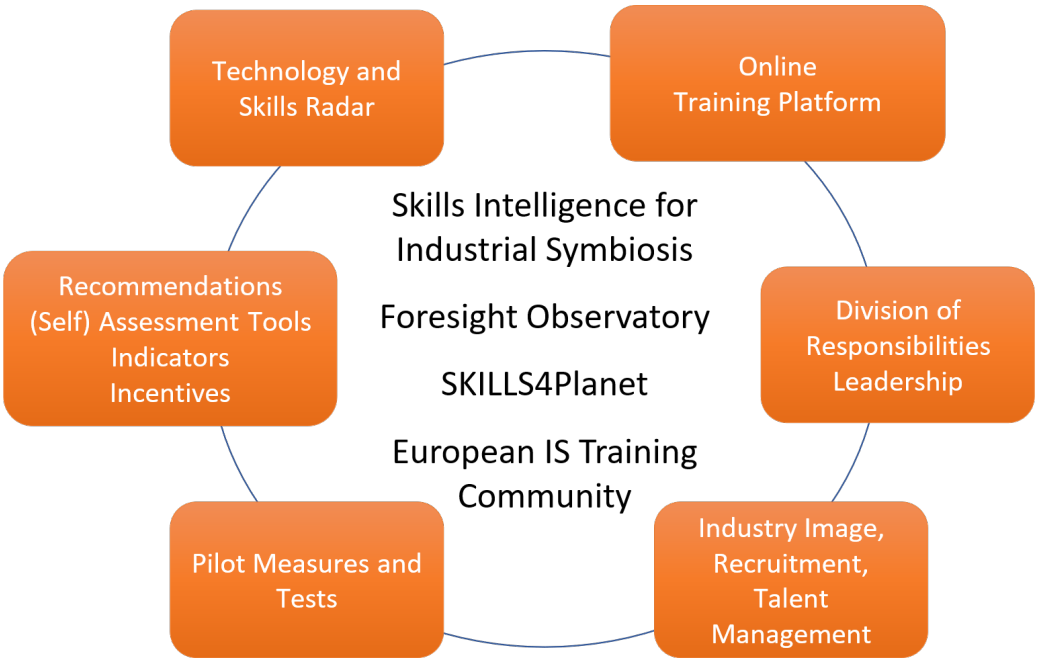


Figure 43: Skills Intelligence Hub and Training Community

Skills Intelligence will be done within the *Foresight Observatory* as the **core element of the coordination of SPIRE-SAIS**, including a regular survey giving insight to 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 annual questionnaires, taking up the methodological and field experience of the SPIRE-SAIS surveys already conducted in 2021 (see chapter 2.3.3) and 2024 (see chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**), but improving and shortening it to the main dimensions. It is foreseen to discuss the quantitative results of the Skills Radar with a number of experts, esp. from the different sectors (e.g. with the Steering Committee Sector Representatives), in workshops or a forum at the website of SPIRE-SAIS.

Additionally, the Foresight Observatory will integrate a **Project Repository**, initially designed for collecting material from partners to develop the desk research for the technological and economic development and skills demands (see Deliverable 2.1; Branca et al., 2024). As this repository is a good reference interesting for the whole SPIRE community and the interested public it is firstly integrated in the SKILLS4Planet platform, but other solutions will be checked as well (A.SPIRE project repository, H4C platform).

5.3.2 European Industrial Symbiosis Training (Framework and SKILLS4Planet Platform)

The SPIRE-SAIS Training Framework (see in detail D5.1; Muract et al., 2024) outlines the structure of the training measures to close identified skills gaps of the identified job profiles for Industrial Symbiosis and related Energy Efficiency. The Training Framework is targeted at generic training courses that impart basic understanding and skills (such as the introduction to industrial symbiosis), job profile and skills topic related courses (business, regulatory, professional/technical, transversal/individual) and with in-depth courses.

Based on or integrated in a generic training module the framework the scheme to manage and act for IS and EE:

- thematic in-depth and advanced training courses (e.g. hydrogen, assessment of financial benefits)
- sector specifications and illustrations (ensuring the sector specific 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 44).

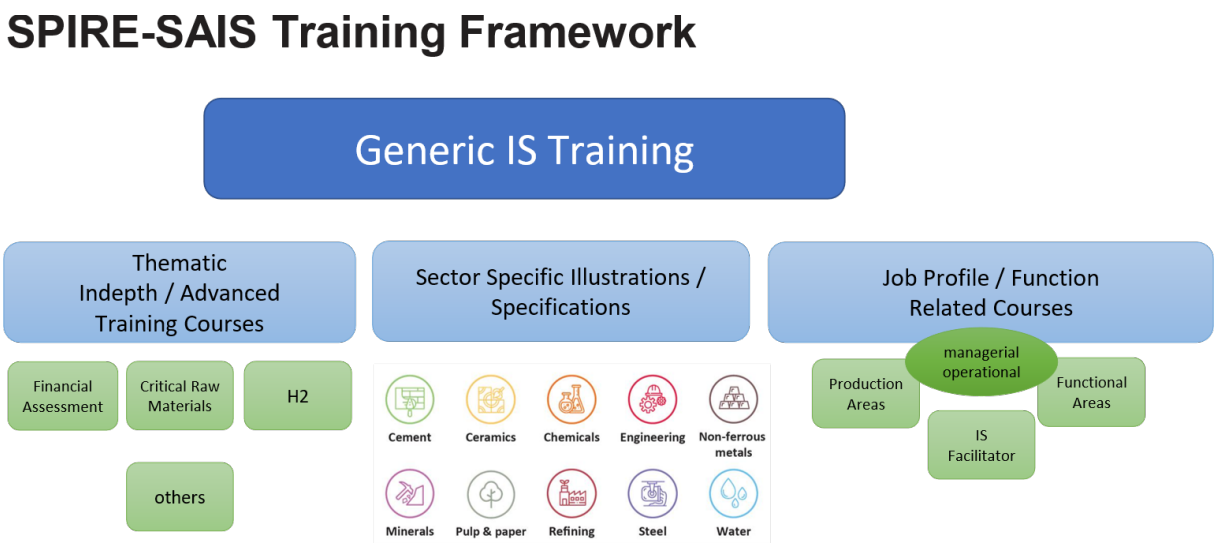


Figure 44: Training Scheme

Against this backdrop, upskilling schemes, mechanisms for implementing tailor-made and demand-oriented trainings were created, leading to the online training platform SKILLS4Planet.

Upskilling schemes

To detect the best upskilling schemes a workshop with companies and training providers about training measures and upskilling schemes compared the experiences of centralised sector specific training systems 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

Industrial Symbiosis related training programs 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* was to find a 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.

Against the backdrop of the results above, an integrating training platform as a one stop and open system space (instead of standalone solutions of specific modules) was foreseen and established: **SKILLS4Planet** online training platform.

This sustainably planned platform centralises and systematise existing training offers and integrates new ones, addressing generic and sector specific skills needs. Challenging is a wide range of thematic issues to be addressed, providing the training offers and materials in different languages, and combining online and theoretical learning with on-the-job training. Even more challenging is to ensure updating and sustainability of the platform after the project life span via an accepted and supported business model.

Online Training Platform SKILLS4Planet

SPIRE-SAIS developed the SKILLS4Planet platform (outlined in detail in Deliverable 5.1; Muract et al., 2024), a centralised digital platform to facilitate communication, collaboration, and coordination. As a central element of the strategic Blueprint and being an ecosystem as well SKILLS4Planet sets the infrastructure for a worldwide exchange of content to create a Learning Solution Directory for the sector. This directory is a collection of learning solutions delivered by publishers into the framework of a marketplace business model.

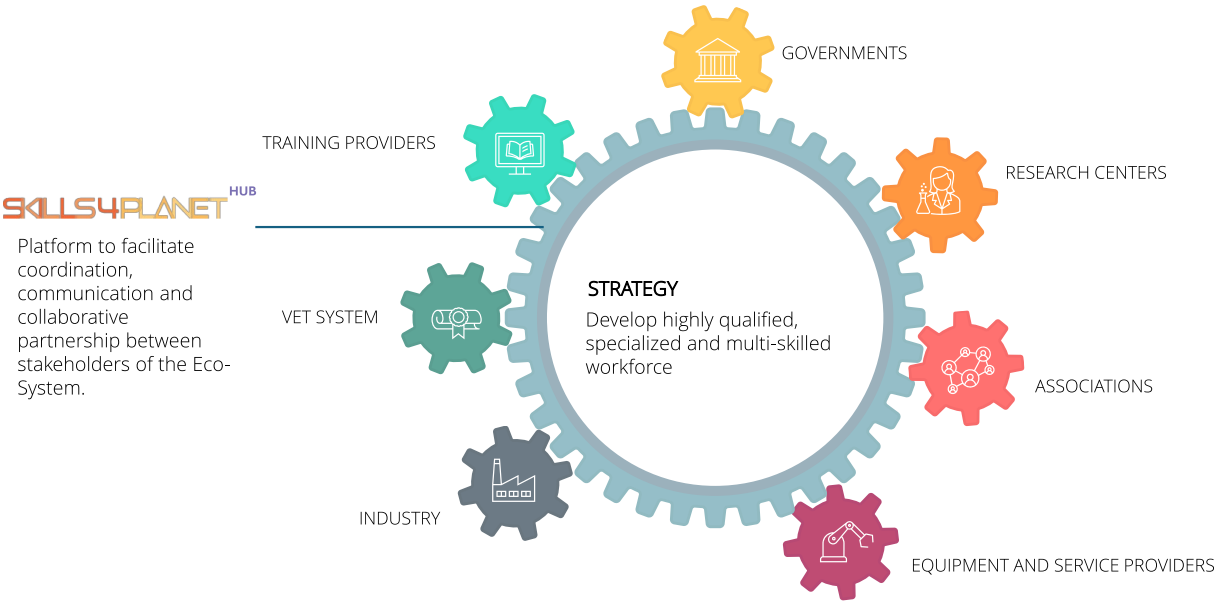


Figure 45: SKILLS4Planet Training Ecosystem

One important component of this platform is the **Skill Directory**, which represents the current and future training needs of the industry identify in WP3 (see chapter 3). This Directory is used to curate learning solutions. Using a standard terminology and big data infrastructure, SKILLS4Planet is able to identify skill gaps and the most demanded skills for Industrial Symbiosis to guide the training solutions development as well as analyze skills related trends that can support governments to define new regulation and funding tools to support the transformation of the Energy Intensive Industries.

The integrated design of the platform offered by SKILLS4Planet enables the possibility to develop new and innovative solutions into the context of a **Capability Assessor** using a variety of methods to evaluate an individual's capabilities, including self-assessment, interviews, tests, and job simulations. The goal of the assessment is to determine whether an individual has the necessary skills and experience to perform effectively in each role, task or skill needed and design a custom development plan for each organization or individuum. The following video[5] is a tutorial of the capability assessor.

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

Beside the Skill Directory and the Capability Assessor a **Learning Solution and Qualification Directory** as well as **Micro-Credentials** complete the central modules characterising SKILLS4Planet (see Figure 46).

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

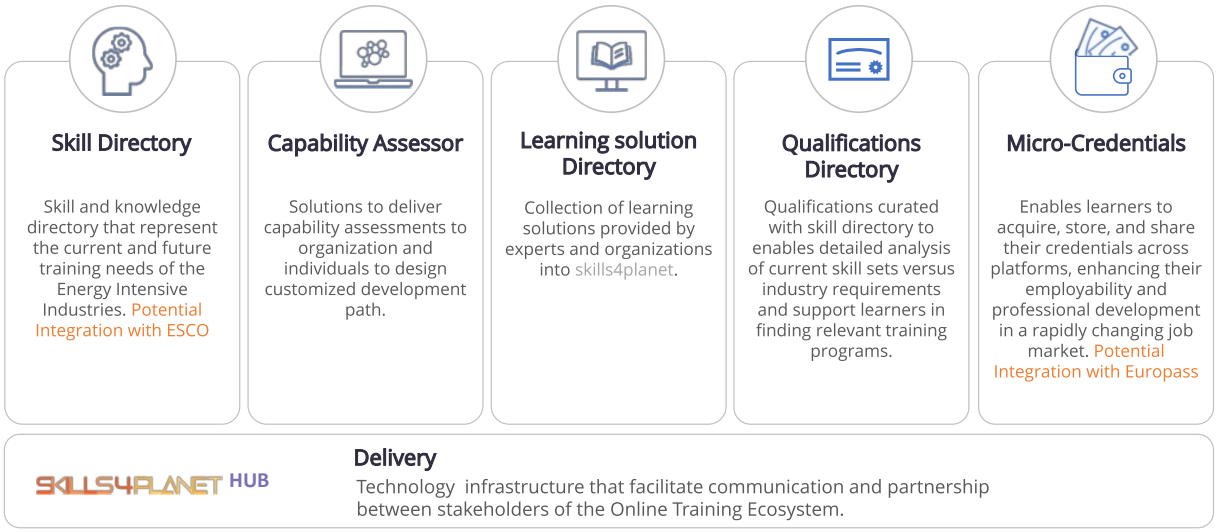


Figure 46: Modules of Digital Platform – SKILLS4Planet

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

1. **Skill Directory**[6], a centralize repository of skills and knowledge that represent the current and future training need of the steel sector.
2. **Capability Assessor**[7], solutions to deliver capability assessments to organizations and individuals for Self-Directed Learning, to support individuals take primary responsibility for planning, organizing, and executing their own learning process.
3. **Learning Solution Directory**[8]**,** which is a collection of learning solutions for up- and re-skilling current and future workforce base on publisher contribution.
4. **Qualifications Directory**[9], A Qualifications Directory is crucial for learners as it provides clarity and guidance on available qualifications, helping them make informed decisions about their educational and career paths. Besides, this directory helps to cross check learning outcomes required by the industry with formal VET programs and curricula to assure a proper alignment.
5. **Micro-Credentials**, Crucial for learners as they offer flexibility, relevance, and speed in acquiring new skills. Focused on specific, in-demand abilities, they enable learners to quickly enhance their qualifications and employability.
6. **Delivery,** flexible IT infrastructure that assure several integration options to meet the unique needs of organizations of different sizes and types as well as individuals. This includes the development of integration solutions for the following cases. Besides, this pillar includes the development and maintenance of a Dashboard with the data collected from the interaction of the learners with these pillars to support the Expert Panel in the identification of emerging skills and training needs.

Based on the analysis of training needs and a collection of already existing educational resources and training courses for IS/EE, the Learning Solution Directory is expanding in two keyways. Firstly, it is growing with the valuable content provided by various publishers. This

[6] https://hub.skills4planet.eu/competencemap/
[7] https://cdn.hub.skills4planet.eu/assets/app/ASMT/index.html#/assessment/intro
[8] https://hub.skills4planet.eu/catalog/
[9] https://hub.skills4planet.eu/catalog/qualifications/

publisher-provided content ensures a diverse and rich array of learning materials available to users, with content from European Projects, training providers, companies, among others illustrated in the following logos.

Figure 47: Logos of SKILLS4Planet training providers

Hydrogen oriented trainings and **trainings for sector newcomers** were and will be further developed with the support of publishers (up to now for steel, ceramics, cement, minerals, water and chemical sectors). For example, American Institute of Chemical Engineers (AIChE) provide 12 courses that cover basic concepts of Hydrogen, production, storage and safety.

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

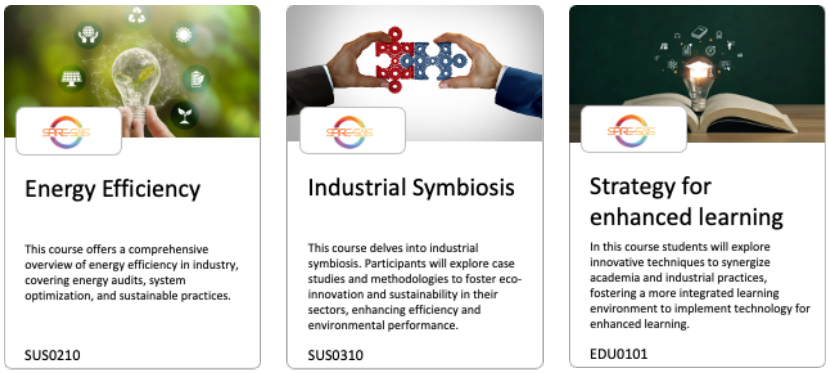


Figure 48: Learning Solutions Developed by SPIRE-SAIS project

5.3.3 Image – Recruitment – Talent Management

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

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

manner, even after the project duration. In this way, SPIRE-SAIS can serve as a basis for follow-up activities in which concerted actions can be developed across different sectors of the process industry. The platform SKILLS4Planet also contains a repository for image and recruitment measures, which will be updated continuously after the project duration. These include current European recruitment events and projects as well as recruitment campaigns and the results of the SPIRE-SAIS project.

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

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. 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

Workshops held as part of Work Package 5 and discussions in the rollouts have shown that the search for applicants in the field of Energy Efficiency appears to be less of a challenge compared to Industrial Symbiosis. As already emphasised, there is no specific job profile for Industrial Symbiosis. However, people with industrial symbiosis skills need to hold senior positions to have the right access and be close to decision makers who have in-depth knowledge of the company structure. Both risk managers for operations and managers for infrastructure integration are needed. However, there needs to be a balance between (young) people with fresh ideas and staff with the right experience, as well as interaction between managers and operators at lower skill levels. The preferred solution of companies, according to the company representatives involved, is to distribute the work in Industrial Symbiosis and Energy Efficiency--related teams and thus rely on the co-operation of several people. This avoids the need for a single person to combine all these skills.

As *compliance 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 Climate Action, 2020).

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

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

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

Against this backdrop the *lack of suitable applicants* in the field of Industrial Symbiosis should be solved by balancing (new) people with fresh ideas with experienced company staff, working in teams. However, imparting skills and knowledge internally (with a focus on in-house talents) is the most suitable and realistic way recently in order to avoid a war for talents and to retain talents in the company. This needs more specific courses, especially in the field of Industrial Symbiosis,on the job and online.

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 insights and examples from the sectoral and regional rollout workshops

The SPIRE-SAIS rollout relates heavily to the topics of image and recruitment. In the rollout, the topic of image and recruitment was discussed many times during the sectoral and regional workshops in connection with Industrial Symbiosis and Energy Efficiency. Connections were fostered during the rollout workshops between different stakeholder groups, which were able to contribute their respective perspectives and topics. Further rollout workshops could address

the topic of image and recruitment even more actively in the future and develop further solution strategies, even after the project duration. Discussion in the rollout workshops also made clear that, through the SKILLS4Planet platform, which offers training programmes focusing on industrial symbiosis (IS) and Energy Efficiency (EE), recruiting can also be facilitated. SKILLS4Planet thereby helps to identify skills gaps and promotes workforce development and strategic planning. By providing detailed insights into the needs of industry, especially companies, SKILLS4Planet enables a better understanding of the specific requirements of each sector, which in turn supports the recruitment of suitable candidates.

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

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

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

It is fundamentally important to emphasise the clear benefits of Industrial Symbiosis. It pushes the boundaries of collaboration between industrial neighbours, offers site-level solutions and connects different sectors. This collaborative potential can be a compelling aspect for industry to work towards common goals, making Industrial Symbiosis an attractive proposition despite its inherent complexity.

When asked whether it is more difficult to attract workers to traditional or green jobs, sector representatives give a nuanced answer. Greener jobs tend to be more attractive as the focus

is increasingly on sustainability. However, it is crucial to communicate that the green transition will bring changes in job roles. Clear explanations and a focus on upskilling and reskilling are crucial to prepare the workforce for these changes. Rather than just differentiating between green and traditional jobs, it makes more sense to discuss the overall transformation of the industry and the opportunities it presents.

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

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

5.3.4 European Open Coordination Integrated in Existing EU Structures

As stated by the European Skills Panorama: "Skills Intelligence is the outcome of an **expert-driven process** of **identifying, analysing, synthesising and presenting** quantitative and/or qualitative skills and labour market information [...] kept up-to-date and adjusted when user needs change. This requires the expert-driven process to be continuous and iterative" (Cedefop, 2019). This is exactly the approach of SPIRE-SAIS, starting already in the proposal phase to accelerate such an expert-driven process by integrating different stakeholder groups of energy intensive industries in a multi-stakeholder and ecosystem approach (quadruple helix: industry, policy, research and education, civil society).

The consortium and associated partners of SPIRE-SAIS bring together the **full range of stakeholders** required to establish a sustainable cross-sectoral strategic Skills Alliance, covering all SPIRE sectors and scoping directly twelve member states from Northern, Eastern, Western and Southern Europe. However, via its sector associations, the alliance covers all the European Member States with Energy Intensive Industries. This ensures a Europe-wide rollout of the SPIRE-SAIS Blueprint engaging with national VET systems and cross-sector European

frameworks to meet skill needs. The partnership includes key industrial associations of all engaged sectors (Chemicals, Steel, Minerals, Non-ferrous Metals, Water, Engineering, Ceramics, Cement, Refinery, Pulp & Paper), and key actors (companies, training providers and research institutions) involved in actual and forthcoming projects of Industrial Symbiosis, Energy Efficiency and VET (skills and qualification needs and solutions). The partnership (consortium and associated partners) is based on and feeds the HORIZON 2020 Public Private Partnership A.SPIRE with more than 170 members (companies, training providers, research institutes) encompassing and 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.*

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

The SPIRE-SAIS Blueprint is not a stand-alone solution. The Blueprint strategy is led by a cooperative approach with a division of responsibilities and leadership. Therefore, the Observatory, SKILLS4Planet and the planned European IS Training Community will be aligned with and support European activities related to European Energy Intensive Industries (see Figure 49), namely:

- Sustainable Process Industry through Resource and Energy Efficiency (SPIRE) and its recent activities, explicitly "Processes4Planet" (P4Planet), its Strategic Research and Innovation Agenda 2050, and its governance structures and working groups
- The Coordinated Support Action “European Community of Practice for Industrial-Urban Symbiosis and Regional Hubs for Circularity and Industrial Urban Symbiosis”
- Central stakeholder groups (social partners, sector associations and unions, policy-makers, education system players, etc.)
- European networks and projects: e.g. the CircLean Network and Circle Economy, the INSIGHT project results for establishing the profile/occupation of the IS Facilitator
- European programs: e.g. European Pact for Skills (especially the Large Scale Partnership Energy Intensive Industries (LSP EII); CEDEFOP Skills Intelligence Platform; European Skills, Competence, and Occupation Database (ESCO).

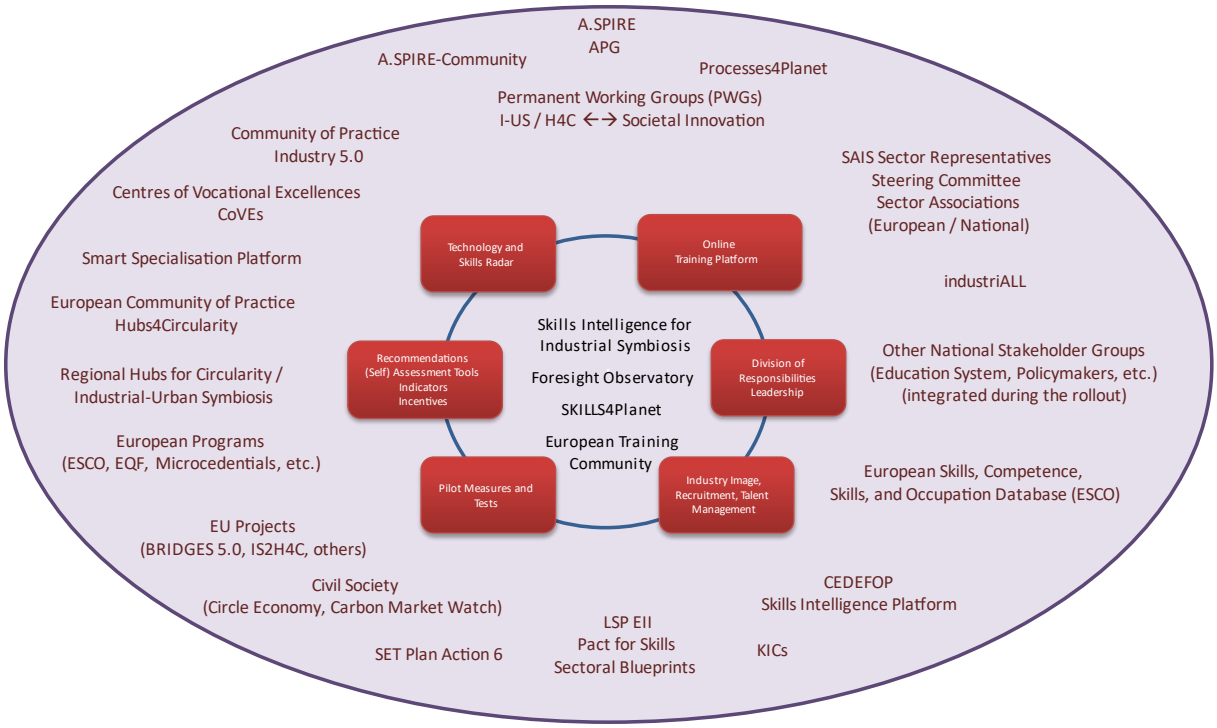


Figure 49: Integration SPIRE-SAIS in European Activities on Energy Efficiency and Industrial Symbiosis

A.SPIRE / Processes4Planet

The central coordination of SPIRE-SAIS has to be aligned with the program and governance structure of the Processes4Planet program (P4Planet) and its Strategic Research and Innovation Agenda 2050 (SRIA; A.SPIRE, 2021b). As SPIRE-SAIS partners are closely integrated in the development of the SPIRE community and the SPIRE Roadmap 2050 “Processes4Planet”, non-technological and social issues were successfully and explicitly integrated in the P4Planet program, placing prominently non-technological issues for improving technology development and competitiveness (esp. through human resources and skills). The agenda foresees to align almost every technological innovation program with non-technological issues (with related investments in a range of 1% to 5% of the project budget) and, additionally, to set up an own innovation program for Human Resources (aiming at a funding of about 42 million Euro from 2020 – 2050).

Within the new advisory and programming structure SPIRE-SAIS is aligned very closely with two Permanent Working Groups (PWG) (see Figure 50):

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

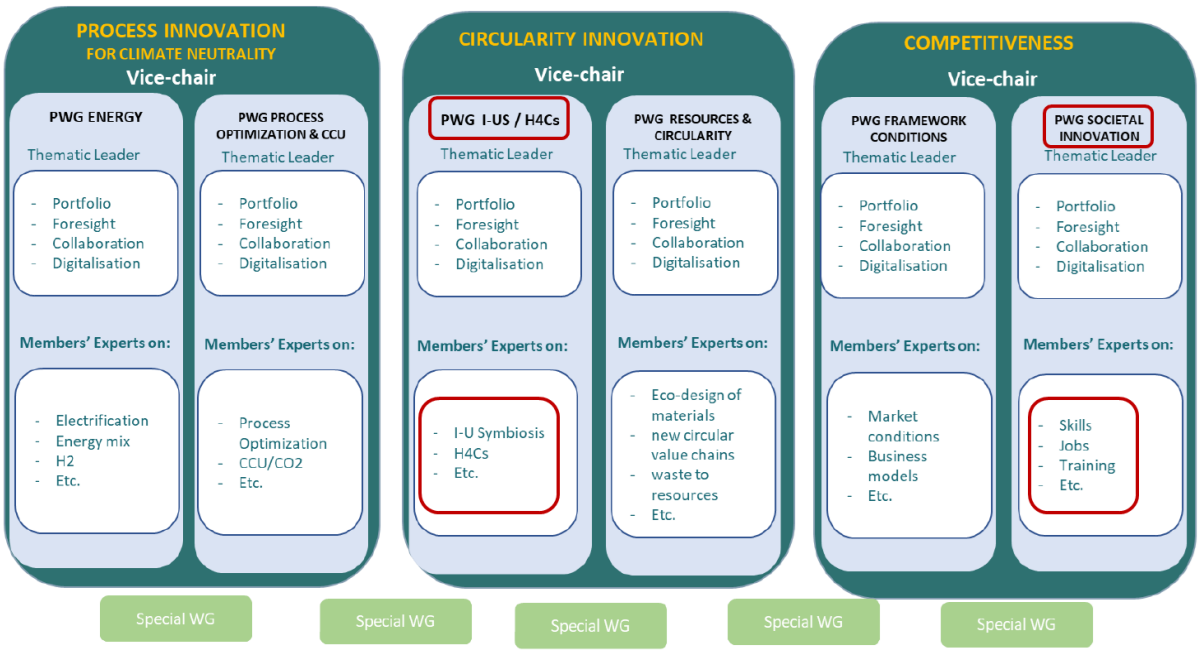


Figure 50: Working Groups of the Advisory and Programming Board of P4Planet

Ensuring a reliable cross-sector representation, SPIRE-SAIS established a "**Sector Representative Steering Committee**" (see Table 8) as a link to the different Energy Intensive and Process Industries, including also the unions and civil society perspective. This important link to combine the cross-sectoral with the sector specific necessities and demands is a mutual exchange platform for feeding the sectors with SPIRE-SAIS results, measures and tools on the one hand, on the other hand giving feedback and inputs from the sectors to improve the SPIRE-SAIS Blueprint and Training Platform SKILLS4Planet.

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

Table 8: Steering Committee „Sector Representatives“

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

To connect SPIRE-SAIS with the national-regional level, we are cooperating with the European Community of Practice of Industrial Urban Hubs for Circularity (ECoP H4C) (H4C Platform). Together with the ECoP, suitable European regions for the further SPIRE-SAIS Blueprint and Training Platform Rollout could be identified reaching high Symbiosis Readiness Levels (SRL) in the region, 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.

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 8**Fehler! Verweisquelle konnte nicht gefunden werden.**) 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 were and will be the main actors for the 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 integrated other (national) stakeholder groups (policymakers, education system players, etc.) with our rollout workshops (see chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**).

European Networks and Projects

SPIRE-SAIS became an approved partner of the European Pact for Skills, a flagship initiative of the European Skills Agenda, now integrated in the Large Scale Partnership Energy Intensive Industries (LSP EII). This LSP EII is an advancement not only of SAIS but also the ESSA Blueprint, guaranteeing the sustainability of both Blueprints and alliances.

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 Processes4Planet, 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, hydrogen, advanced manufacturing, batteries, digital). As steel is one of the SPIRE sectors, we collaborate esp. with the European Steel Skills Alliance (ESSA) and the Clean Steel Partnership (CSP) of ESTEP, where skills are part of the building block "Enablers" (see CSP Strategic Research and Innovation Agenda; ESTEP, 2021). 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 280 EE and IS related EU (past and ongoing) funded projects (such as MAESTRI, COPRO, SHAREBOX, EPOS, SPRING, see Deliverable D2.1, 2024). A repository is published at SKILLS4Planet platform.

The Blueprint is connected closely via associated partnership and taking advantage of EE and IS skills related networks (like CircLean 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. Further European or sector specific platforms will be examined for dissemination and rollout, esp. the European Cluster Collaboration Platform and their sector related clusters: e.g. steel, ceramics, water or engineering.

European Programmes, 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, Almeida & all WP leaders, 2020, 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 Processes4Planet, Clean Steel and HORIZON Europe cluster 4, 5, 6 will be inspired by SPIRE-SAIS partners and results continuously.

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 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 51). A strong integration in the SPIRE Community, its Processes4Planet 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.

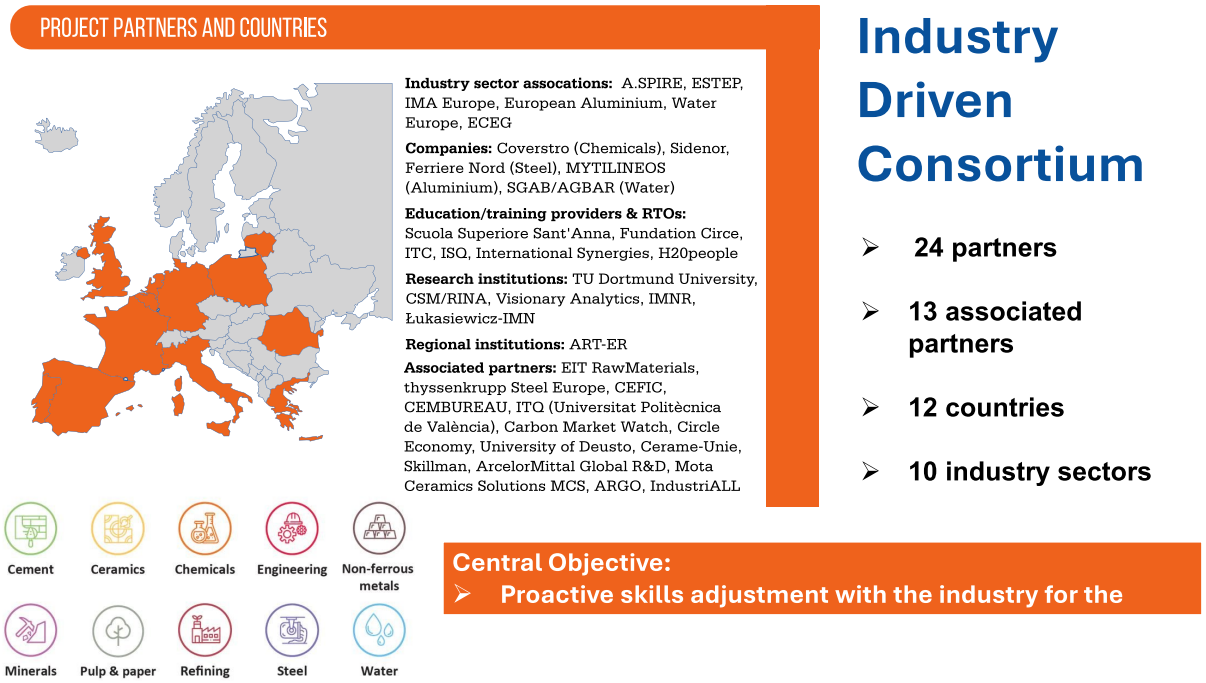


Figure 51: SPIRE-SAIS Partnership

To establish a sustainable European Skills Alliance for Industrial Symbiosis **beyond the project life span** with a reliable leadership and governance on the **European level** we systematically linked the European Blueprint 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 P4Planet under Horizon Europe) and its main coordination activities (e.g. Strategic Innovation and Research Roadmap 2050, General Assemblies, Workshops like Hubs4Circularity), almost all partners are involved in these activities, not at least because they are members of A.SPIRE.

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

tion). 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 43), the Skills Alliance is aligned with the main European coordination units:

- European: Via A.SPIRE to The Sustainable Process Industry through Resource and Energy Efficiency (SPIRE) and its recent activities, namely "Processes4Planet" (P4Planet) and its Strategic Research and Innovation Agenda (see A.SPIRE, 2021b), 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 rollout activities and the cooperation with the European Community of Practice for Industrial-Urban Symbiosis, completed by involved regional associations and platforms (such as ART-ER and ARGO)
- Multi-sectorial: Via the Large Scale Partnership Energy Intensive Industries (LSP EII) of 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 Figure 52) will be further developed with the relevant stakeholders and leaders via the LSP EII. Objective is a deep and mutual involvement of SPIRE-SAIS in the European, national and regional sector governance and activities, in both directions: informing the different sectors by SPIRE-SAIS results, tools and activities and informing SPIRE-SAIS by recent sector activities on Industrial Symbiosis on the European, sectorial, national, and regional level. Within these governance structures cross-stakeholder activities are initiated and launched, as well as internal integration of skills adjustment within the activities of the associations, unions, companies, and training providers.

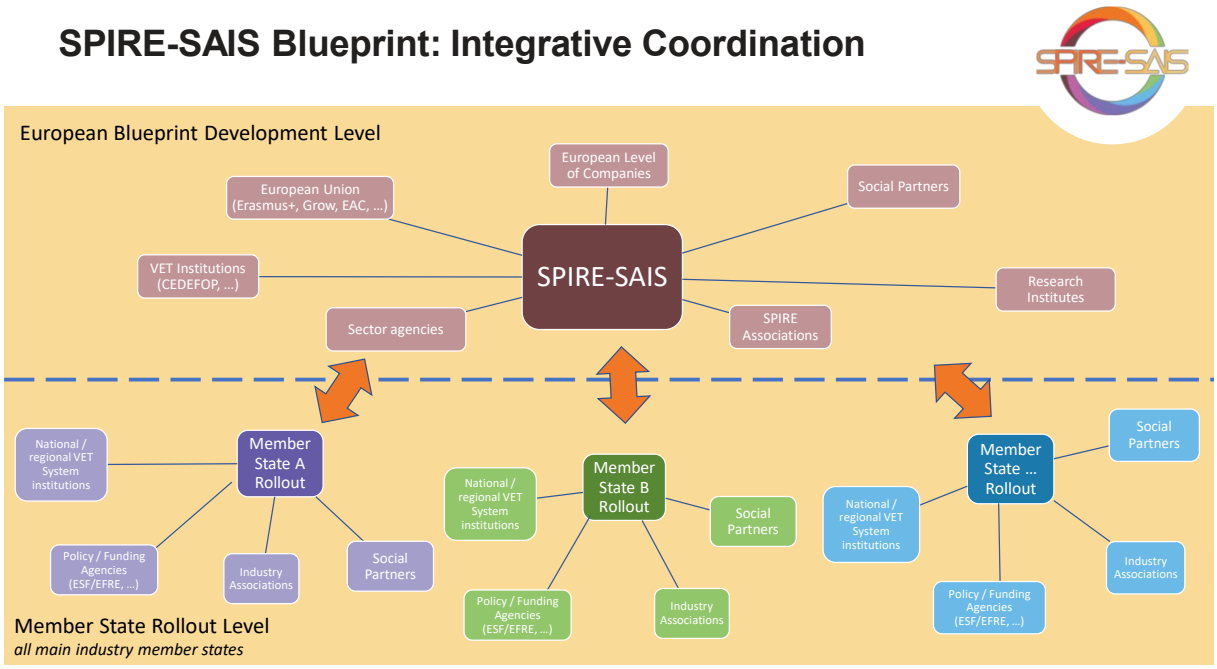


Figure 52: European sectoral national Coordination of SPIRE-SAIS

5.4 Summary

The SPIRE-SAIS Blueprint addresses industry skills demands through the establishment of Skills Intelligence via a Foresight Observatory, an Online Training Platform (SKILLS4Planet), and a European Training Community for Industrial Symbiosis. It involves continuous observation of technological, economic, and societal demands to develop strategies and measures, supported by new or existing alliances and leadership. The Blueprint encompasses demand, supply, and coordination aspects.

The SKILLS4Planet platform is a centralised digital platform that supports continuous skill updates and training, offering interactive and open online training courses, pilot measures, incentives for best practices, and industry image campaigns for recruitment. It includes a Skills Directory, Capability Assessor, Learning Solution Directory, Qualifications Directory, and Micro-Credentials, while providing a flexible IT infrastructure and integration options for various organizations and individuals.

Recruiting skilled workers for energy-intensive industries is challenging, but tools like the SKILLS4Planet platform and SPIRE-SAIS rollout offer valuable solutions. These efforts address skills gaps, foster regional collaboration, and focus on continuous workforce development, improving talent attraction and retention and contributing to a more sustainable and competitive industry.

The SPIRE-SAIS Blueprint aims to meet industry skill demands through a comprehensive strategy involving continuous observation, skills intelligence, and training platforms. Key elements include:

- **Skills Intelligence and Foresight Observatory:** Regularly updates on technological and economic demands and skills requirements.
- **Training Framework and SKILLS4Planet:** An online platform offering interactive training courses and resources for Industrial Symbiosis and Energy Efficiency.

- **Image and Recruiting:** Campaigns to attract talent to the process industry.
- **European Coordination:** Aligns new alliances and governance with existing European structures and ensures sustainable implementation.

The Blueprint focuses on demand-driven skills adjustment, proactive and sustainable strategies, and fostering cooperation among stakeholders to enhance human resource capabilities in technological development. It thereby integrates training with real workplace needs and ensures sustainability beyond the project lifespan through business models and market orientation.

6 Transfer and Implementation of the Blueprint (WP6)

Building out of the outcomes of the previous chapters (WPs 2, 3, and 4) and their transmission into the Blueprint (WP5), transfer and implementation plans, strategies and actions were developed in close cooperation with dissemination activities and policy recommendations (WP7). Against this backdrop, the developed European Blueprint was implemented, tested and improved. Rollout (and dissemination activities, see next chapter) ran from the very outset of the project and through the whole project life-cycle to ensure relevant, applicable, visible and reflected results. All project partners were and are involved with their access and activities to the European industry.

6.1 Objectives

WP6 aims at planning suitable implementation and transfer actions at companies and training providers at European, Sectoral, Member State and regional level that involve companies, associations and VET system institutions. Collaboration was also established with other Blueprint developing industry sectors.

Starting on outcomes from WPs 2, 3, and 4 and on the Blueprint strategies and training tools (WP5), WP6 includes the development of implementation and dissemination plans for the Blueprint strategies, including the definition of the contents that will be used in the implementation actions, by considering the differences in national VET systems.

In addition, suitable Key Performance Indicators (KPIs) are used to monitor success and adjust needs continuously in respect to the implementation of the Blueprint goals and to adjust the skills agenda and strategy.

6.2 Concept and Methodology

On the basis of the implementation (Deliverable 6.1; Schröder et al., 2022) and exploitation plan (Deliverable 6.3; Schröder, Branca, and Woodcock (2024)), the concept for the SPIRE-SAIS rollout was further developed throughout the project. The rollout thereby focuses on the *sectoral level* and on the *regional level*.

SPIRE-SAIS is applying the well-known European Open Coordination method. Skills adjustment are coordinated via SPIRE-SAIS' Skills Intelligence and Training Platform on the European level, aligned with the A.SPIRE community and the planned European Community of Practice of Industrial Symbiosis (ECoP). Additionally, the rollout of the Blueprint at the sectoral and national level is mainly advised by the different sector associations (encompassed in the SPIRE-SAIS Steering Committee Sector Representatives) and the entire 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 was focused on two selected Industrial Symbiosis regions engaging public VET and Higher Education authorities.

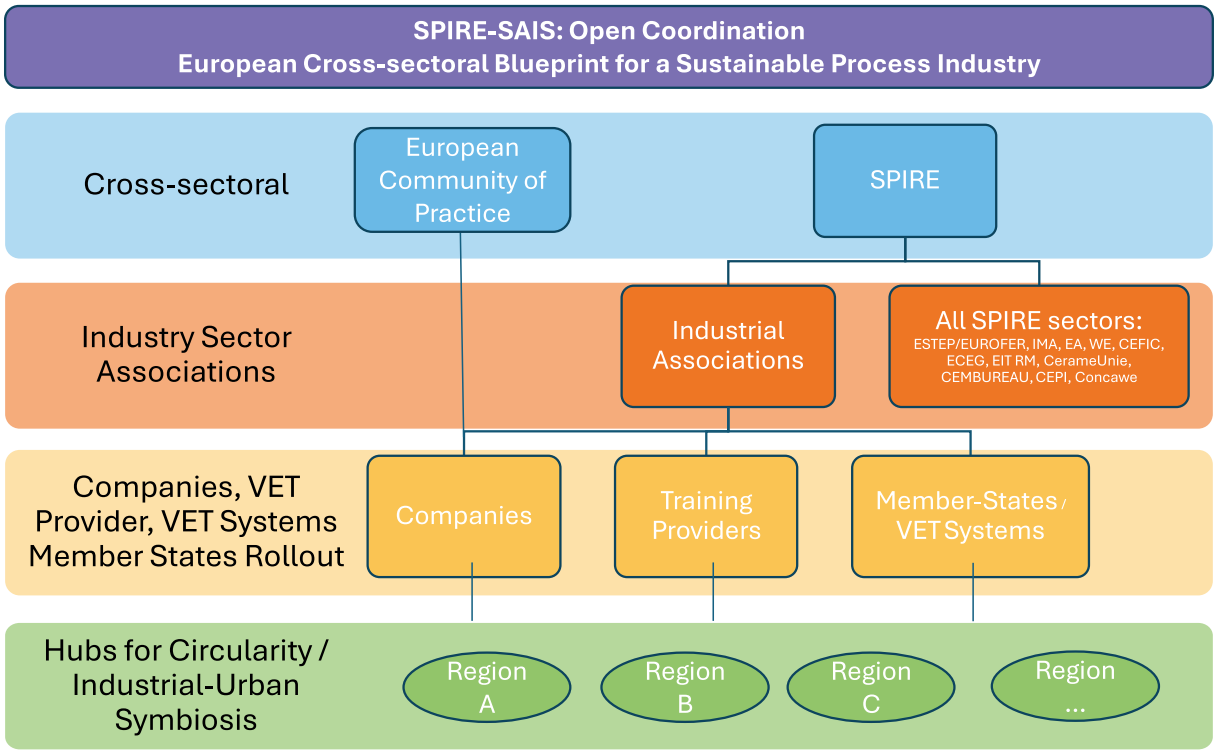


Figure 53: European-sectoral-national-regional Rollout with Open Coordination

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

By also following a **regional approach**, SPIRE-SAIS was able to consider regional challenges and opportunities. After all, different regions have different environmental priorities, legal frameworks and available resources (such as types of waste or energy sources) that are relevant for IS and EE. A regional approach makes it possible to address these specific regional characteristics. In addition, a variety of sectors are often represented in the individual regions, resulting in cross-sectoral synergies. Regional workshops can thereby foster cross-sector collaboration and create innovative, symbiotic relationships that drive skills development and

training for IS and EE. A SPIRE-SAIS rollout at the regional level enabled the broader participation of stakeholders, including local governments and educational institutions, who can support and strengthen the implementation of training measures.

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

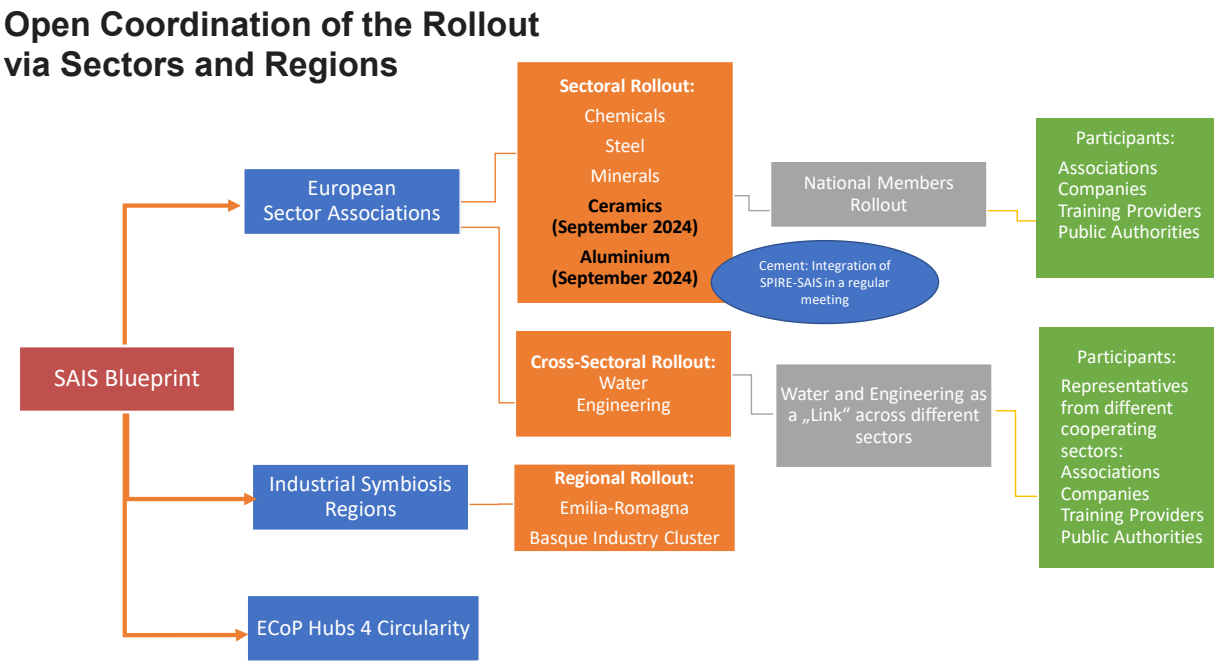


Figure 54: SPIRE-SAIS Rollout Concept

The SPIRE-SAIS rollout was organised in the form of pilot workshops and round table discussions with stakeholders from the respective sectors and regions. The individual workshops were scheduled to last around 3 hours, whereby great importance was attached to interactive elements and a lively exchange with the participating stakeholders. The rollout activities included the following target groups: (a) education entities and training bodies, (b) companies' experts, practitioners and engineers, (c) decision-makers at local, regional, national and European level, and not at least (d) the sector associations and their members. The SAIS partners of the respective sectors and regions helped organising and took part in the workshops, while associated SAIS partners as well as new interested and relevant organisations were also integrated into the rollout.

In the first rounds of workshops, it was particularly important to verify stakeholder interest and ensure that the various stakeholder groups were willing to participate in events and drive processes forward. Above that, it was also important to have a reliable point of contact for each rollout sector and rollout region to provide support with invitations and the definition of key topics. Thereby and as already mentioned, for the sectoral rollout, SPIRE-SAIS was engaging the sector associations as nodes to the members of their specific sectors (Chemical, Water, Ceramics, Raw Materials, Cement, Aluminium, Minerals, Engineering, Refinery, Pulp and Paper). For the regional rollout, regional organisations (such as ART-ER in the Italian region of Emilia-Romagna) were the main points of connection.

The SPIRE-SAIS rollout followed an **ecosystem approach**. The aim was to develop and strengthen a successful partnership in the respective sectors and regions. In this way, a skills and training ecosystem is to be created that integrates various stakeholder groups from different sectors of society in the sense of a quadruple helix. The focus was on the four groups of

education and training providers (1), small and large businesses (2), public authorities (3) and civil society actors (4).

Roughly summarised, the main objectives of the rollout were the dissemination of the SPIRE-SAIS results (including the SKILLS4Planet platform, the training courses and identified skills/job profiles), as well as the promotion of sectoral/regional cooperation and processes on skills development and training for Industrial Symbiosis (IS) and Energy Efficiency (EE). At the same time, feedback on the actual challenges of individual sectors and regions were to be obtained in order to further refine the SPIRE-SAIS tools accordingly. This made it possible to integrate industry demands for the tools and results that were developed and obtained in SPIRE-SAIS. The exchange between the stakeholders present also enabled new learning opportunities to be identified for the respective sectors and regions and new support structures to be established.

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

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

6.3 Results

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

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

Here are some of the most important topics and discussion points of the rollout workshops:

Uptake, cooperation and awareness for IS:

- The important task of raising awareness for a circular approach in general and for Industrial Symbiosis in particular was among the most discussed topics in the rollout workshops.
- The term Industrial Symbiosis often seems new, even though many of the practices are already in use.
- The added value of Industrial Symbiosis has to be clearly demonstrated. - Knowledge creation and viable business cases are some of the main motivators fuelling the adoption of Industrial Symbiosis.
- It is often not possible to easily replicate IS practices: Companies often redevelop their own solutions instead of sharing and strategically collaborating, also making it difficult for companies to analyse and constantly update the changing skills and qualification requirements.
- The challenge is to apply valuable IS solutions in companies without having to reinvent the wheel every time.
- Among the main challenges for the uptake of Industrial Symbiosis is the lack of connections between companies, especially in terms of information and communication, in combination with a lack of channels and connectors.

Training for Industrial Symbiosis:

- Skills development and training are among the most important tasks with regard to the implementation of Industrial Symbiosis and Energy Efficiency.
- Identifying the necessary skills is a major challenge for companies and a first step that must be taken before employee training is even possible.
- EU policies often evolve and change faster than training offers; it thereby seems challenging to quickly adapt the training offer to the increasing requirements of EU policies.
- Not only technical skills are important in the topics of Industrial Symbiosis and Energy Efficiency, but above all transversal skills and soft skills can facilitate co-operation between different sectors.

Talent Attraction & retention in energy-intensive industries:

- Challenges with regard to skill needs and recruiting differ regionally.
- Industrial Symbiosis processes often depend on the skills of individual persons, which increases the need for further education and training.
- The topics of talent attraction and talent retention should always be considered in order to ultimately develop and integrate IS-related competences.

6.4 Summary and Next Steps

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

The rollout workshops revealed specific needs and solutions at regional and sectoral level, which in turn were used to adapt and further develop the overarching European tools (such as SKILLS4Planet) for skills development. At the same time, these tools were and are applied

and disseminated at regional and sectoral level. Despite the complex diversity of actors, backgrounds and organisational logics, this enables a process of joint social innovation that efficiently and effectively promotes the decarbonisation and circularity of European industry.

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

Therefore, the pilot rollout workshops are only a first step. They have to be continued and extended. As the rollouts for the aluminium sector and the ceramics sector are planned for the second half of 2024, it shows the need for continuity beyond the project life span. Especially the further integration of the SPIRE-SAIS Blueprint and the European SKILLS4Planet Training Platform within further regions and sectors should lead to an incorporated European Community of Training Practice (ECoP). Within regional training ecosystems (including public authorities and policy, big companies and SMEs, social partners, educational organisations and training providers, as well as civil society organisations), the SPIRE-SAIS European Training Platform could

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

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

7 Policy Recommendations and Dissemination (WP7)

Policy recommendations and dissemination activities are informed by the results of all the SPIRE-SAIS activities (work packages results) and deliverables. This includes besides the distribution and proceeding of results in the industry also the cooperation with policy makers, other sectoral Blueprints as well as the integration of SPIRE-SAIS results in the existing EU tools and platforms (such as Skills Intelligence of CEDEFOP, ESCO, and others).

7.1 Objectives

Based on the SPIRE-SAIS results and activities, a dissemination strategy was developed and related activities were conducted and monitored during the whole project duration and will be done beyond the funding period. Additionally, based on the outcomes of the activities carried out in the different areas (work packages) and according to the Blueprint framework, policy recommendations are defined and structured in the form of recommendations and guidelines. Having said this, it becomes evident that there is a close connection between dissemination and rollout strategies and activities.

All the themes related to Industrial Symbiosis and Energy Efficiency concern a complex framework of actions that include the understanding of economic, social and political dynamics and the relationship with the territory interested by a relevant and, in some cases, heterogeneous

industrial presence as well as the needs to foresee and promote the creation of a network able to manage a new way of sustainability in industry sectors. Our network comprises stakeholders (private and public), policy makers, companies, public authorities, able to share all the information and data in order to speed-up a real flow of “resources” among the different industries but also to appoint a “cockpit”, a direction entity to assure a governance in the perspective of Industrial Symbiosis implementation.

SAIS project considers the most complex frame for the dissemination and implementation of the policy recommendations. This will allow to exactly identify the policy makers and stakeholders (which are not already part of the SAIS consortium) and to address the defined guidelines in an optimal way.

To sum up, the main objectives of this work package are:

- to identify, implement and secure necessary political support measures by mobilising and integrating stakeholders and policy makers of the EU and national level
- to define policy recommendations on the basis of the activities and results of SPIRE-SAIS
- to secure the rollout of the Blueprint in the relevant member states
- to improve the public image of the European process industry sector as a modern, high-tech, sustainable and green industry.

Dissemination is dedicated to spreading and discussing the SPIRE-SAIS findings in a broader sense in the whole Energy Intensive and Process Industries but also within related industries and environments (e.g. within the Processes4Planet co-programmed partnership).

Through a dissemination strategy (and the rollout activities) we aim at:

- Raising awareness
- Assuring and extending an effective impact
- Engaging stakeholders and target groups
- Sharing solutions and know how
- Influencing policy and practice
- Developing new partnerships and alliances.

7.2 Methodology

Dissemination and policy recommendations are placed as the main SPIRE-SAIS "branding" defined and based (a) on the main findings of the SPIRE-SAIS activities, and (b) considering the perspective of the targeted stakeholder groups, (c) enhancing the cross-sector and cross-border approach involving relevant national, regional and local players, mobilising and integrating stakeholders towards Blueprint aims and objectives. Recommendations also stress the cooperation among them, each one with its own peculiarity and mission. Key target groups – the main target of the dissemination activities - are:

- Education and training institutions: aligning offered VET skills sets, reaching mutual added value by cross-fertilisation of education and training programs, complementing curricula mutually with skill offers
- Learners / students: supporting teachers and other staff of education and training institutions in the above activities
- Companies: focusing on job role-based certification and job role-based training
- Workers: supporting companies in the above activities

- Policy-makers: ensuring there is no administrative, legal or any other barriers for the implementation of the strategy at national and regional levels
- Associations and social partners: encouraging education and training providers, companies and their peers (e.g. social partners at lower level) to uptake the blueprint
- Networks and communities, such as Pact for Skills industrial ecosystem members, and others.

Secondary target groups are:

- General public: showing the attractiveness of the IS/EE sectors' future technical development; looking attractive to young people or those willing to change activity by upskilling engagement
- Press and media
- Academics
- Stakeholders of other sectors related to Industrial Symbiosis and Energy Efficiency industry sectors.

Political support will be essential to assure an effective adoption of the policy recommendations and for the rollout of SPIRE-SAIS to the selected European regions. The strategy is aiming at involving the main European, sectoral and national stakeholders according to their institutional mission or field of interest. Dedicated events (e.g. meetings, seminars or webinars) and publications have been held to present the Blueprint results and to share the most suitable measures to give political and technical support to policy makers and stakeholders in the member states.

To accomplish the goals of the Blueprint, political support includes that the legislative context, both at European and National levels, has to be considered with particular reference to the compliance of the policy recommendations with European and national legislative framework. The aim is to ensure that the main rights of the workers (i.e. health and safety at work, equal opportunities for women and men, protection against discrimination based on sex, race, religion, age, dis-ability and sexual orientation, etc.) are respected.

The impact of technological and economic developments (mainly dedicated to Industry 4.0 technologies and visions) aligned with respected skills demands and training support are stressed, also in order to identify working positions more susceptible of intervention (for instance in the direction of human-centricity of the Industry 5.0 concept.

Another important aspect to be covered is related to the working conditions included in the labour laws (part-time work, fixed-term contracts, working hours, employment of young people, informing and consulting employees, etc.) and in the companies due to new working conditions (e.g. homeworking, work-life balance, remote working and learning). There are multiple items to be taken into consideration: from binding legal instruments (regulations, directives and decisions) to non-binding instruments (resolutions, opinions), company related programs, up to other instruments (EU institutions' internal regulations, EU action programmes, etc.).

7.3 Results

7.3.1 Dissemination

Dissemination started already shortly before the official project start and has been ongoing throughout the project lifetime and will be continued. A dissemination plan was defined both

for spreading the project results and making the planned policy recommendations more effective. The SPIRE-SAIS Final Conference has showcased the recommendations to policy makers, industry associations, social partners, and national Vocation Education and Training (VET) institutions and other stakeholders.

The dissemination strategy comprises a mix of dissemination activities to achieve project visibility and to gear contents towards the intended audience:

- The (public) SPIRE-SAIS website (https://www.aspire2050.eu/sais) is part of the A.SPIRE homepage to ensure sustainable operation after the project duration and, during the project, maximum integration and dissemination among companies and stakeholders of A.SPIRE Association. The website reports the project's progress and results with news and newsletters, deliverables and event information.
- Project leaflets both in paper and in electronic form were published in English, French, German, Greek, Italian, Portuguese, Romanian and Spanish. Videos and simulations to illustrate main outcomes are considered for the final results of the projects.
- SPIRE-SAIS approach and results have been presented in workshops, conferences, training courses webinars and other events, due to the accessibility to them by the consortium (and associated partners) with a focus on involving stakeholders and policy makers (e.g. the Sectoral Social Dialogue Steel, Covestro conferences on Industrial Symbiosis, Water Innovation Europe Working Group Human Capital, Eurosteelmaster yearly courses, Circular Economy Stakeholder Conference, A.SPIRE brokerages and info days, Processes4Planet meetings, just to name a few).
- An intermediary (March 2022, online) and final conference (May 2024, in Dortmund, Germany) presented the results to the industrial sectors and interested public. The Final Conference agenda consisted of a broad range of stakeholders' intervention and presentation of the project's final results, policy recommendations and showcase of the SKILLS4Planet online training platform.
- Scientific publications, contributions to conferences, publications in magazines were elaborated to present project's results and promote a debate on SPIRE-SAIS themes in the European (and not only) scientific community.

The partnership includes a complementary mix of strategic partners, including all the relevant stakeholder groups of the European Energy Efficient Industry. Not only for dissemination but transfer and exploitation all partners collaborate in the dissemination activities according to the type of organisation (industry, academia, industry association, etc.) by taking advantage from the networks they are engaged in, coordinated by a communication officer also in charge of social media posts. The whole project partnership is committed to delivering the necessary skills to industry and invest in the workers' employability. SPIRE-SAIS is strongly supported by the process industry platform A.SPIRE and by sectoral platforms (ESTEP, IMA, EA, WE, IMN, ECEG, EIT Raw Materials, Cerame-Unie, CEFIC, CEMBUREAU) to provide the permanent cross-sectoral basis for setting skills agendas and developing the right skills policies in close cooperation with EU policymakers. Implementing the Skills Alliance Strategy and Blueprint is the main driver of the SPIRE-SAIS consortium and dissemination and promotion measures.

SPIRE SAIS website (https://www.aspire2050.eu/sais) has been set-up at the beginning of the project within the A.SPIRE homepage to ensure sustainability. It is frequently updated with relevant project internal and external news, in order to create an interactive collaboration among the partners and stakeholders. A specific section of the project website is devoted to

the list of documents generated by the project, with a pdf version, including the SPIRE newsletters. Digital newsletters (but also printable) have been and will be published to disseminate the project results of the different deliverables.

There is also a “hidden” dissemination result concerning the wide knowledge that the project has achieved in Europe thanks to all the work done, considering the high amount of person, professionals, teachers, VET providers, national and regional public and private institution and stakeholders contacted at different level and interviewed along all the work done (and to improve in the future).

A lot of dissemination activities spread the news about SPIRE SAIS, but the first months of 2020 the COVID-19 pandemic has completely blocked many onsite dissemination events, meetings, workshops and other relevant occasions to spread the project’s results and achievement. Dissemination strategy and events already planned since early 2020 have been reorganized as online events or postponed without relevant diminution of effectiveness. SPIRE-SAIS partners obtained from other on-line events relevant inputs for the Blueprint (e.g. ESTEP seminars, different meetings and seminar organised in the frame of A.SPIRE and Processes4Planet Partnership). However, the SPIRE-SAIS consortium has preferred to postpone or reorganise some events considering the characteristics of the event; e.g. because of the need of alliance building, personal exchanges and commitments and the need to meet people in person to discuss in the most effective, creative, interactive and dynamic way the SPIRE SAIS results and future activities.

Uncertainty about the course of the pandemic and the development and duration of the different waves force the project coordination to make decisions using the utmost caution in planning project events and meetings at any level, considering and trying to anticipate the possible difficulties of movement between the member states to which the partners belong and the most obvious health precautions for the containment of the virus that must be applied for the organization of events and meetings.

However, the used methodology led to:

- A pro-active, targeted and direct dissemination and exploitation strategy, aimed specifically at decision makers and Human Resources stakeholders of industrial-urban symbiosis and Energy Efficiency across the different sectors of SPIRE, but also aimed at connecting the project related to other industrial sectors and Blueprints (e.g. Automotive, Construction, Advanced Manufacturing, Hydrogen)
- A common visual identity of the project and related branding and marketing strategy.
- Raising awareness in the IS/EE sector and beyond (other industry sectors, employment agencies, VET and employment institutions, and others), sensitising and engaging key stakeholders.
- Engaging existing networks and platforms (e.g. Sectoral Social Dialogue Committee Steel, ESTEP, EUROFER, Sector Skills Councils, European Junior Water Program, the national IS/EE Clusters and platforms, H4C Platform, IndustriALL, Circle Economy, Skillman, etc.) for feedback, inputs, dissemination and exploitation in a continuous way. These platforms are the arena for maintaining the Blueprint profile and disseminating the message to a huge number of companies and sector stakeholders/decision-makers at the local, regional, national and European level.

7.3.2 Policy Recommendations

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

The policy recommendations summarised in the following (see in detail Deliverable 7.1; Tropeoli et al., 2024) have been grouped according to the level of stakeholders addressed, such as European, national or general (overarching).

Overarching Policy Recommendations:

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

European Policy Recommendations:

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

National and Regional Policy Recommendations:

- National policymakers should collaborate with sectors, VET institutions, and industry organisations, to promote green skills and train teachers to provide current theoretical and practical knowledge to students
- Develop monitoring and evaluation tools to better assess existing green skills delivery instruments and the educational programs' effectiveness
- Incorporating green skills into national secondary education systems

- Create a unified skills recognition system
- Ensure the integration of EE and IS concepts and (online training) tools into the qualification processes at the national and VET school level
- Develop training for intersectoral transitions
- Develop a train-the-trainer strategy to increase educators' readiness
- Incentivise employers to provide training opportunities for employees

Specific Recommendations for Individual Companies and Organisations:

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

7.4 Summary

Dissemination activities were and will be continuously done, starting already before the project officially began and continued throughout its duration, with a plan to continue spreading results and policy recommendations and running the SPIRE-SAIS website continuously as part of the A.SPIRE homepage, ensuring ongoing visibility, updates on progress, and integration among stakeholders. Results were presented at various events, including workshops, conferences, and webinars, involving key stakeholders and policymakers. An intermediary online conference (March 2022) and a final conference in Dortmund (May 2024) showcased results and the SKILLS4Planet training platform.

Policy Recommendations comprise general and overarching ones, European, National and Regional, as well as company level ones to address the different stakeholders).

With this SPIRE-SAIS achieved significant dissemination through various activities, also adapting effectively to challenges posed by the COVID-19 pandemic. The developed policy recommendations aim to integrate skills adaptation into strategic policies and provide tools for continuous improvement in green skills training across different levels.

8 Outlook: Large Scale Partnership Energy Intensive Industries under the European Pact for Skills

Sustainability of SPIRE-SAIS is given by founding the **Large Scale Partnership Energy Intensive Industries** (LSP EII) under the Pact for Skills, pushed and established by SPIRE-SAIS and ESSA in May 2023. With the LSP EII, a **common all energy-intensive process industries comprising framework and alliance** was created based on the alliances and results of the two Blueprints SPIRE-SAIS (cross-sectoral and Industrial Symbiosis skills specific blueprint) and ESSA as a specific (steel) sector-related blueprint including an incremental upskilling of representative job profiles (t-shaped skills: technical and transversal skills (green,

digital, social, individual, and methodological)). The LSP EII is not only ensuring the exploitation of SPIRE-SAIS (and ESSA) results, measures and tools, but also bringing the development forward to a higher level by compiling synergies of both blueprints and extending the focus to additional sectoral and regional in-depth trainings, rollouts, and marketing activities. Additionally, both online training platforms steelHub (ESSA) and SKILLS4Planet (SPIRE-SAIS) will be linked, opening training courses for each other and connected further under a common umbrella HUB5.0 with additional learning solutions, the development of micro-credentials and extended support possibilities.

With a cross-sectoral exchange strategy and alliance, the LSP EII will dynamically detect and adjust future skills demands in line with the ambitions of the Process Industries European Strategies (e.g., P4Planet's Strategic Research and Innovation Agenda, ESTEP Strategic Research Agenda and Clean Steel Partnership CSP). Alignment with other European programs and activities will ensure the integration of the EIIs skills perspective (esp. Erasmus+, Horizon Europe, P4Planet, CSP calls and projects). Possible complementarities with the Raw Materials Academy managed by the EIT Raw Materials will be explored toidentify new areas for skills-focused actions. Rollout to the different sectors, member states, selected regions (esp. through Hubs4Circularity Community of Practice, sector related clusters, Centres of Vocational Excellence) is planned to be done by the members of the Pact for Skills through different means (e.g., platforms, events, workshops). This can be done in collaboration with European Communities of Practice, the Pacts for Skills Support or other.

Within this framework, the further exploitation and development of SPIRE-SAIS will guarantee the sustainable running and rolling out of the Blueprint on the European, sectoral, national and regional levels. The exploitation strategy has a double aim:

(1) transferring the Blueprint to national and regional decision makers and other sectors;
(2) convincing and integrating more end-users in the further social innovation development process (esp. companies, education and training providers and workers/learners) to integrate new trainings and to implement common strategies.

With the partnership of the LSP EII and other Pact for Skills members we submitted a proposal Skills Alliance for the Green, Digital and Social Transformation of the Energy-Intensive Industries (Skills4EII). This was done to use and further expand the already existing ecosystem infrastructure of the ESSA and SPIRE-SAIS for a Europe-wide rollout, taking advantage of the already established stakeholder relationships and distributed responsibilities in the ESSA and SPIRE-SAIS projects as an ideal basis. The objective is not only to disseminate and discuss the results and the tools developed, but also to continuously assess needs and ensure openness with regard to possible key issues, in order to provide maximum added value to sector representatives and regional stakeholders. Independently from the approval of the proposal, the rollout and further development of ESSA and SPIRE-SAIS will therefore have a cross-sectoral, a sectoral and a national-regional focus.

We will interact also with new Blueprints (such as ChemSkills) and projects (e.g. ECoP H4C, IS2H4C, BRIDGES 5.0, BEYOND 4.0, greenSME, RACE) and EU programs (such as Industry 5.0 and the Community of Practice Industry 5.0). Industrial Symbiosis for Hubs for Circularity (IS2H4C) for instance addresses not only the technological, but also the economic and social aspects of Hubs4Circularity. The requirements, interests and needs of all relevant stakeholders will be considered based on the basis of a stakeholder engagement framework. This framework will include the perspective of associations, trade unions, work councils, employees and their perspective on skill needs for a circular economy. Furthermore, citizens will be involved

in new H4C solutions when circular solutions in industrial parks are extended to surrounding ecosystems (e.g. use hydrogen for heating in households, use of hydrogen for public transport).

The LSP EII consolidates the relationships established between stakeholders to take the next steps towards a sustainable European process industry. The specific challenges for Energy Intensive Industries are in line with the pillars of Industry 5.0:

- They need to become more sustainable to meet the requirements of the European Green Deal and their specific responsibilities as a major player in energy consumption and CO2 emission.
- They need to become more resilient to be less dependent on fragile supply chains that can severely affect production and competitiveness.
- They need to become more human-centric to use the skills developed to harness skills for sustainable growth, increased innovation and competitiveness.

Within the LSP EII SPIRE-SAIS contributes to the European Green Deal and the EU´s Twin Transition, as well as to the New Skills Agenda for Europe and the new concept of Industry 5.0. Complementarity and essential input to industry related EU programmes will be ensured through the stakeholders involved: namely Net-Zero Industry Act, Critical Raw Materials Act, Processes4Planet, Clean Steel Partnership, SET Plan Action 6, CoP Industry 5.0. Obviously, skills related engagement with other Sectoral Blueprints (e.g. Hydrogen, Automotive, Advanced Manufacturing, Batteries) and the Pact for Skills is central as well. Cooperation with and contributions to CEDEFOP's Skills Intelligence programme and cross-linking with the ESCO database are key as in the use of skills related results and outcomes from other European projects.

Annex

SPIRE-SAIS Partners

Consortium Partners

Technische Universität Dortmund (TUDO)	technische universität dortmund	https://sfs.sowi.tu-dortmund.de/
Rina Consulting - Centro Sviluppo Materiali Spa (RINA/CSM)	RINA	https://www.rina.org/en/
A.SPIRE	ASPIRE PROCESSES4PLANET RESEARCH ASSOCIATION	https://www.aspire2050.eu/
Scuola Superiore di Studi Universitari e di perfezionamento SA (SSSA)	INSTITUTE OF COMMUNICATION, INFORMATION AND PERCEPTION TECHNOLOGIES Scuola Superiore Sant'Anna	https://www.santannapisa.it/it
European Aluminium Association AISBL (EA)	EUROPEAN ALUMINIUM	https://www.european-aluminium.eu/
Industrial Minerals Association Europe (IMA)	IMA Europe	https://ima-europe.eu/

Instituto de Soldadura e Qualidade (ISQ)		https://isq.pt/en/
The European Steel Technology Platform (ESTEP)		https://www.estep.eu/
Asociacion de Investigacion de Lasindustrias Ceramicas aice (ITC-AICE)		https://www.itc.uji.es/en/
Fundacion Circe Centro de Investigacion de Recursos y Consumos (CIRCE)		https://www.fcirce.es/
Ferriere Nord Spa		https://www.pittini.it/
Sidenor Aceros Especiales SL		https://www.sidenor.com/en/
International Synergies LTD (ISL)		https://www.international-synergies.com/

Water Europe (WE)		https://watereurope.eu/
Instytut Metali Niezelaznych (IMN)		http://www.imn.gliwice.pl/index
Covestro Deutschland AG		https://www.covestro.com/
Institutul National de Cercetare-Dezvoltare pentru Metale Neferoase si Rare (IMNR)		https://imnr.ro/
Suez Groupe		https://www.suez.com/en

AGBAR/SGAB (replacing Suez)		https://www.agbar.es/
Visionary Analytics UAB (VA)		https://www.visionary.lt/
H20-People B.V.		https://juniorwaterprogramme.eu/
ART-ER		https://en.art-er.it/
MYTILINEOS		https://www.mytilineos.gr/
European Chemical Employers Group (ECEG)		https://www.eceg.org/

Associated Partners

IndustriALL		https://news.industriall-europe.eu/
EIT Raw Materials		https://eitrawmaterials.eu/
ThyssenKruppSteel Europe		https://www.thyssenkrupp-steel.com/
CEFIC The European Chemical Industry Council		https://cefic.org/
CEMBUREAU The European Cement Association		https://cembureau.eu/
Cerame-Unie The European Ceramic Industry Association		http://cerameunie.eu/
Carbon Market Watch		https://carbonmarketwatch.org/
Instituto de Tecnología Química Universitat Politècnica de València (UPV) – Consejo Superior de Investigaciones Científicas (CSIC)		https://itq.upv-csic.es/en http://www.cpi2020.es/

University of Deusto		https://www.deusto.es/cs/Satellite/deusto/en/university-deusto
Circle Economy		https://www.circle-economy.com/
Skillman		https://skillman.eu/
ArcelorMittal Global R&D		https://corporate.arcelormittal.com/
Mota Ceramics Solutions MCS		https://mota-sc.com/en/home/
ARGO		https://www.areasciencepark.it/

Abbreviations

Abbreviation	Meaning
4R	Reduce, Reuse, Recycle, Restore
5R	Reduce, Reuse, Recycle, Restore, Re-educate
CCRI	Circular Cities and Regions Initiative
CCS	Carbon Capture and Storage
CCU	Carbon Capture and Utilization
CEN	European Committee for Standardization
CoP	Community of Practice
CSP	Clean Steel Partnership
CVET	Continuing Vocational Education and Training
D	Deliverable
DG	Directorate-General
EC	European Commission
ECESP	European Circular Economy Stakeholder Panel
ECoP	European Community of Practice
ECQA	European Certification and Qualification Association
ECTS	European Credit Transfer and Accumulation System
ECVET	European Credit System for Vocational Education and Training
EE	Energy Efficiency
EFRE	European Regional Development Fund
EIIs	Energy Intensive Industries
EntreComp	Entrepreneurship Competence Framework.
EQF	European Qualifications Framework
EQAVET	European Quality Assurance in Vocational Education and Training
ESCO	European Skills, Competences, Qualifications and Occupations
ESF	European Social Fund
ESF+	European Social Fund Plus
ESSA	European Steel Skills Agenda
ESSC	European Sectoral Skills Council
EU	European Union

FG	Focus Group
FP6	Sixth Framework Programme
FP7	Seventh Framework Programme
H2020	Horizon 2020
H4C	Hubs for circularity
HE	Higher Education
HEU	Horizon Europe
HR	Human Resources
ICT	Information and communications technology
IS	Industrial Symbiosis
ISCED	International Standard Classification of Education
ISCO	International Standard Classification of Occupations
ISO	International Organization for Standardization
I-US	Industrial-Urban Symbiosis
IT	Information technology
IVET	Initial Vocational Education and Training
JECE	Junior Expert in Circular Economy
KPI	Key Performance Indicator
LCA	Life Cycle Assessment
LSP	Large scale partnerships
MFA	Material Flow Analysis
NEET	Not in Education, Employment or Training
NISP	National Industrial Symbiosis Program (?)
NGO	Non-governmental organisation
P4Planet	Processes4Planet
pre-VET	pre Vocational Education and Training
PWG	Permanent Working Groups
RFCS	Research Fund for Coal and Steel
RRI	Responsible Research and Innovation
SET Plan	Strategic Energy Technology Plan
SMEs	Small and medium-sized enterprises

SPIRE-SAIS	Skills Alliance for Industrial Symbiosis – A Cross-sectoral Blueprint for a Sustainable Process Industry
SRIA	Strategic Research and Innovation Agenda
SRL	Symbiosis Readiness Levels
STEM	Science, technology, engineering, and mathematics
VET	Vocational Education and Training
WP	Work package

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Skills Assessment Examples: Energy Manager and Liquid Waste Treatment Operator

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		

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		

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