



Symbio-Steel: Fostering Industrial Symbiosis solutions for the steel sector

Valentina Colla – Scuola Superiore Sant'Anna (SSSA), Italy

Han Yu – Swerim, Sweden



- Background
- The Symbio-Steel project
 - Main and specific objectives
 - Aims and scope
 - Consortium
 - Expected Results
- Current achieved results
 - Recent achievements of Industrial Symbiosis in the steel sector
 - Monitoring and assessing the impact of Industrial Symbiosis initiatives
- Conclusions and future work



designed by freepik



Industrial Symbiosis



- Transactions between different industry sectors, also involving technological and non-technological challenges.
- The use by one company or sector of underutilized resources from another.
- Industrial Symbiosis implementation results in:
 - reducing dependence on critical materials, mitigating supply risks
 - replacing virgin materials

 • reducing CO₂ emissions
• transforming existing resources in the value chain into a usable form



Industrial Symbiosis in EU Steel Industry

- avoiding waste production
 - re-using waste and by-products as resources, minimizing their production
 - exploiting by-products as a resource.
-
- Exploring Industrial Symbiosis between the steel sector and other industries
-  redefining inter-industry collaboration, enhancing resource efficiency, and fostering sustainability



Objectives

Symbio-Steel focuses on the current state, upcoming techniques, and developments of Industrial Symbiosis implementation, to reach proactive cross-sectorial cooperation and integrations.

Overall objective:

paving the way to a wider uptake of Industrial Symbiosis solutions in the steel sector, exploiting and spreading knowledge on most promising and available results, supporting synergies with other industrial sectors.



Main objectives

Monitoring and assessing impact of Industrial Symbiosis initiatives on the steel sector.

Assessing Industrial Symbiosis with respect to the transformation of the steel industry to decarbonized next generation steelmaking.

Development of guidelines on how to enhance Industrial Symbiosis in the steel industry.

Meeting skills demands and attracting young talents.



Aims of Symbio-Steel

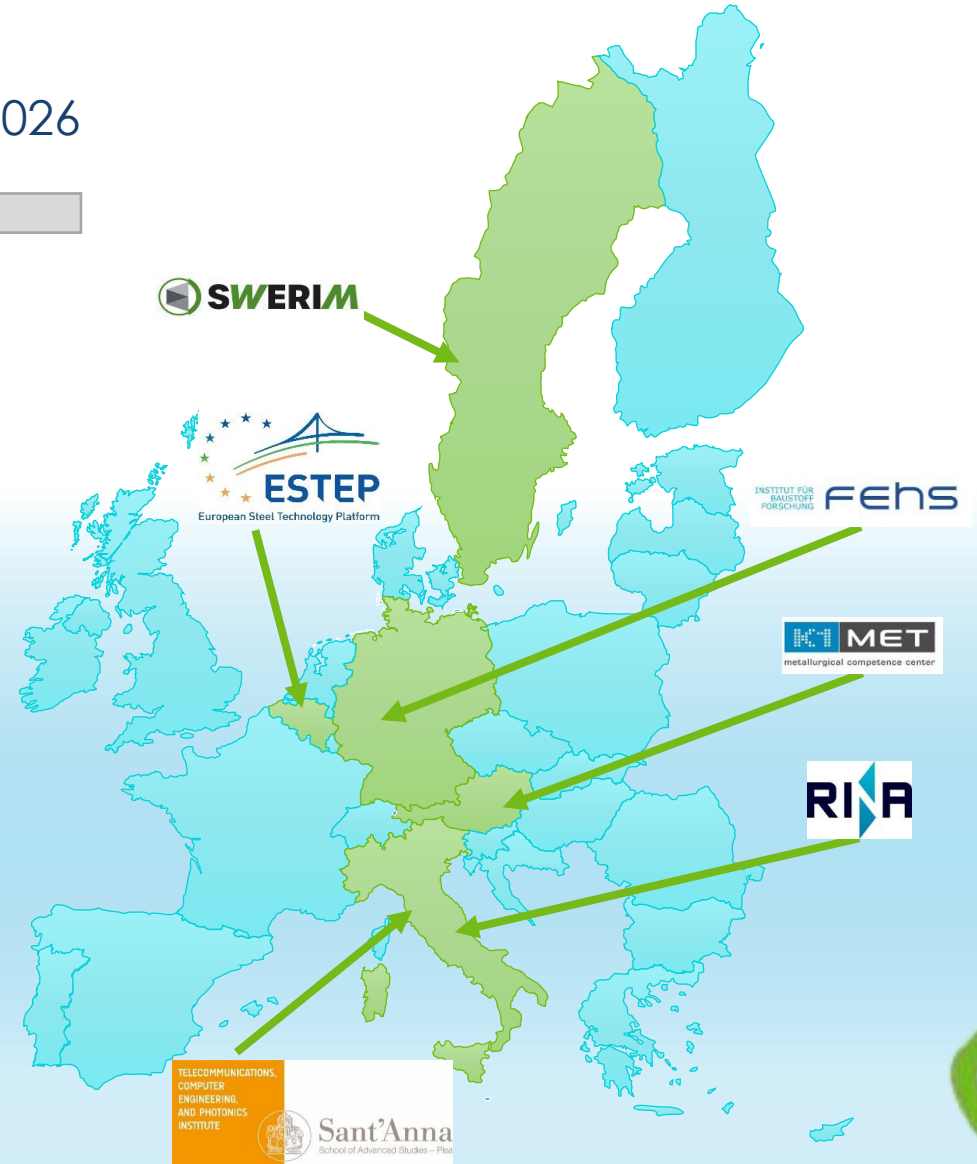
- Analysis of the achieved results on **Industrial Symbiosis**
- Encouraging new opportunities
- Creating **new synergies** and networks with other sectors
- Identifying the main **drivers** and specific **barriers**
- Identifying the main **impacts** on companies, environment, and society
- Considering aspects and features of existing and new **networks** for new **decision-making**
- Analysis of research outcomes
- Designing **dissemination** measures
- Implementation of **new synergies** addressing economic, environmental, and societal drivers.

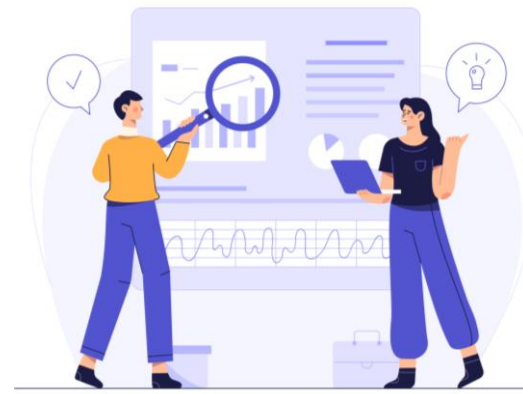
The Symbio-Steel Consortium



6 partners from 5 EU countries

- 1 Academia
- 4 RTOs leaders in the steel sector
- The European Steel Technology Platform





Expected results

- Spreading most promising **research results**.
- Monitoring and assessing the impact of Industrial Symbiosis initiatives through selected and/or **elaborated KPIs**.
- Assessing and disseminating innovative Industrial Symbiosis solutions contributing to the transition towards **C-lean steel production**.
- Identifying **gaps and potential** for initiatives engaging different industrial sectors.
- Developing a virtual forum to **engage stakeholders** within and beyond steel.
- Developing **implementation scenarios** involving energy intensive industries.
- Providing **policy recommendations** to EC identifying the important future R&D issues and optimal use of funding opportunities.
- Providing **guidelines** on how to enhance uptake of Industrial Symbiosis in the steel sector by improving sector coupling.
- **Road mapping** to future Industrial Symbiosis with respect to next generation steelmaking.
- Supporting **attraction and retention of young talents** by involving them in workshops, webinars, and seminars.



Recent achievements of Industrial Symbiosis in the steel sector

- A comprehensive overview of recent studies on the research trends on
 - Industrial Symbiosis
 - Drivers and barriers to its implementation
 - Recent achievements in the steel sector
- Analysis of some significant case studies
 - CO₂ valorisation in flue gases and steel slags to produce silicates and carbonates via mineral carbonation
 - CO₂ capture, re-use and sequestration by symbiotic activities between the steel and ammonia/urea sectors



Recent achievements of Industrial Symbiosis in the steel sector

Outlining the evolution of Industrial Symbiosis over the last few years

Identifying the challenges for future research activities

Creating new symbiotic networks, further developments and scenarios for the steel industry





Monitoring and assessing the impact of Industrial Symbiosis initiatives

- Selection *ad-hoc* defined relevant Key Performance Indicators (KPIs)
- Measuring the effectiveness of Industrial Symbiosis in the steel sector and in other energy-intensive industries
- Definition and selection of KPIs to be used within the Industrial Symbiosis context in iron and steelmaking and other energy- and CO₂-intensive sectors



Monitoring and assessing the impact of Industrial Symbiosis initiatives

- Defining and monitoring KPIs:
- providing quantitative and qualitative insights into measuring the progress of Industrial Symbiosis activities
- analyzing the main results of completed or ongoing projects

List of KPIs related to the Symbio-Steel project	
KPI I	Energy efficiency
KPI II	Direct CO ₂ emissions (Scope 1) reduction
KPI III	Reduction in virgin raw material usage
KPI IV	Enhancing the recycling of low-quality steel scrap
KPI V	Slag recycling rate
KPI VI	Dust and sludge recovery and reuse
KPI VII	Recycling rate of iron-rich residue streams
KPI VIII	Replacement rate of fossil carbon materials
KPI IX	CO ₂ capture rate from process/off-gasses
KPI X	Share of carbon content in process gas (CO ₂ /CO) transformed into products
KPI XI	Technology readiness level



The defined KPIs

- address CO₂ emissions reduction, recycling rates, and resource reuse.
- evaluate the implementation of IS, ensuring a consistent approach for analysis and reporting.
- provide a starting point for monitoring and reporting the progress of relevant actions that the funded national, regional, and EU projects are taking to advance Industrial Symbiosis.
- identify new synergies with other industries and policy recommendations
- achieve an effective industrial rollout of sector coupling technologies, in which the EU steel sector plays a central role



- The **replacement of fossil-based carbon materials** (KPI VIII) appeared as the most widely addressed target.
 - In several projects → feasibility of substituting coal and coke with carbon alternative sources (e.g. biochar, polymers from plastic waste, RDF, and industrial residues), while maintaining process efficiency.
- **Direct CO₂ emissions (Scope 1) reduction** (KPI II): another of the major targets within projects.
- **Valorisation of solid residues, such as slags, dusts, and sludge** (KPIs III, V, VI, and VII).
 - In some projects → full or near-complete recycling of these materials, integrating them into construction, agriculture applications, etc.
 - Reduction of the dependency on virgin raw materials
 - Minimization of waste and residues generation and landfilling.
- Some KPIs - KPI I (**Energy efficiency**) and KPI IV (**Enhancing the recycling of low-quality steel scrap**), were underrepresented:
 - areas for **further research** and **data collection** for KPIs monitoring.

➤ **Communication and dissemination work**

- Tasks: Enable future exploitation by disseminating project results to relevant stakeholders, ensuring wide communication to scientists, engineers, and the public, documenting all dissemination and communication activities, and managing IPR in line with EC guidelines.

➤ **Main activities:**

- Participating in 4 events to introduce Symbio-Steel plan and progress, exchange knowledges and engaging stakeholders (EUROSLAG 2024, ESTEP&FehS: Slag Workshop, ESTEP Spring Dissemination Event, EUBCE 2025)
- 3 Presentations for the SymbioSteel overview and achieved results.
- 1 workshop in Duisburg during ESTEP&FehS event.
- 1 Poster in EUROSLAG 2024, 1 Poster with survey in ESTEP Spring Dissemination Event, 1 Poster in EUBCE 2025.
- First newsletter has been published, the second newsletter is coming by the end of September.



➤ **Communication and dissemination work**

➤ **Progress:**

- Highly active website and LinkedIn page, with more than 12 000 impressions and more than 300 reactions in LinkedIn, with over 100 followers within the first year.
- For more details about the project, welcome to follow our LinkedIn page and visit our website:



LinkedIn page



Website: www.symbiosteel.eu



Subscription to newsletter



- Extracting unified KPIs it is quite difficult, as each research initiative tends to assess the goodness of its results with self-defined KPIs that are difficult to compare.
- Research on IS solution address a large variety of different fields and topics, therefore selection and elaboration of KPIs for the analysis was a quite difficult task.
- The contribution of IS solutions to reduction of CO₂ emissions is not always clear.
- However, as each project contributes to one or more KPIs, practical pathways toward low-carbon, resource-efficient industrial systems are demonstrated.
- In addition, there are many other aspects related to the environmental impact which are relevant to consider for the sustainability of steel production.
- Stakeholders' engagement is fundamental to identify gaps and design future initiatives on IS.



- Promoting fruitful knowledge exchanges and new synergies
- Contributing to achieve higher TRLs levels of identified technologies
- Disseminating projects' results on innovative solutions and strategies for reducing resource and energy uses and related environmental impacts and investment needs.
- Attracting relevant stakeholders in implementing measures

➤ Please compile our survey!

<https://www.surveymonkey.com/r/Y5Z82JT>





- Welcome to follow the LinkedIn page, visit our website, and subscribe to our newsletter:



LinkedIn page



Website: www.symbiosteel.eu



Subscription to newsletter

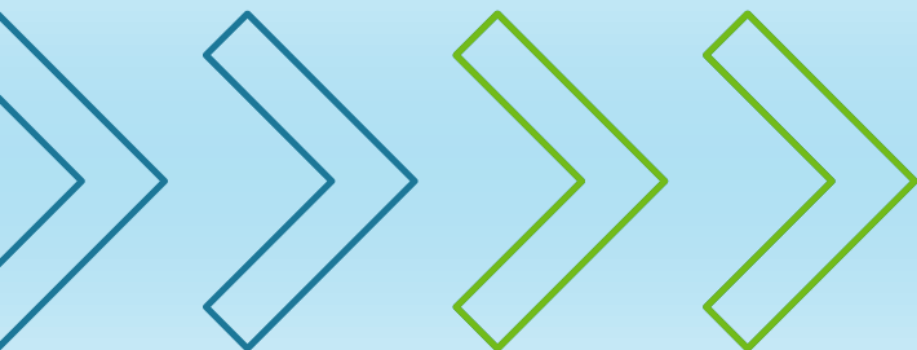
Thank You for Your attention!

valentina.colla@santannapisa.it

han.yu@swerim.se



SYMBIO
STEEL



Project funded by the Research Fund for Coal
and Steel (RFCs) G.A. 101156509