Review of recent achievements of Industrial Symbiosis in the steel sector

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Introduction

The steel sector is a major contributor to global CO_2 emissions, making its transformation essential for climate neutrality. Industrial Symbiosis (IS) enables the exchange of materials, energy, and by-products between industries, supporting circular economy strategies. In steelmaking, IS allows the reuse of slags, gases, and waste heat across sectors. However, its large-scale implementation remains limited by technical, economic, and regulatory barriers.

The SymbioSteel project

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

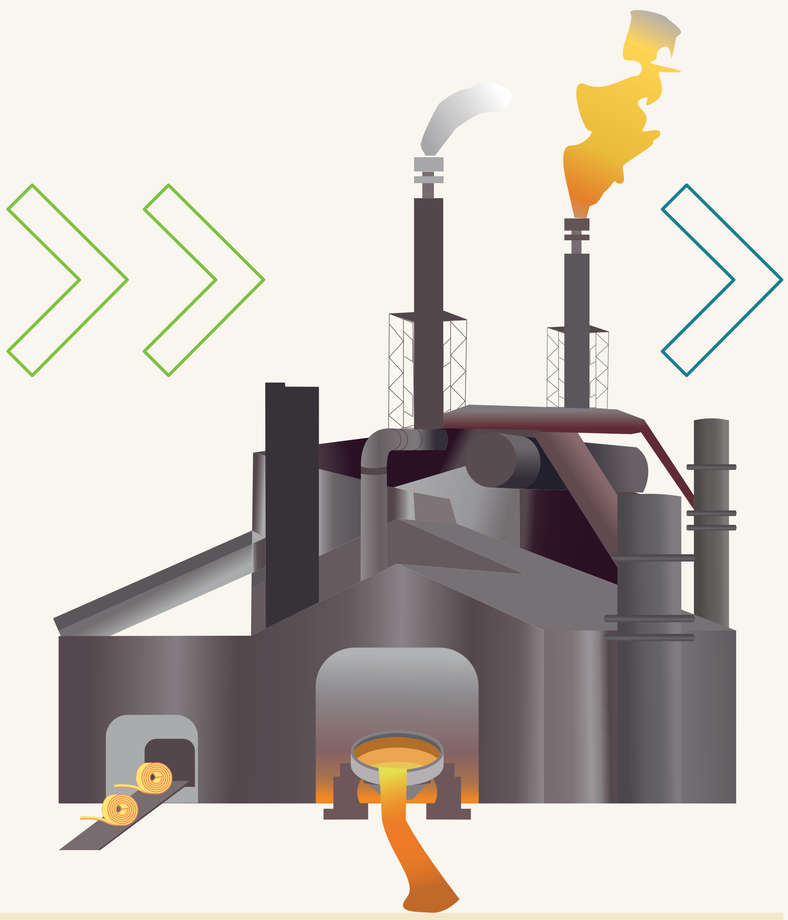
Overall objective: paving the way to a wider uptake of Industrial Symbiosis solutions in the steel sector, exploiting and spreading knowledge on most promising and available results, supporting synergies with other industrial sectors.

Review: as part of the project, a review of recent research activities related to industrial symbiosis in the steel industry was performed. A final number of 49 articles written between 2019 and 2025 were selected to be analysed in a systematic literature review. A number of different sectors, avenues of research, opportunities and challenges were identified.

Steel symbiosis opportunities and challenges

Alternative feedstocks help reduce lifecycle impact and fossil emissions

Alternative input materials
- Biofuels
- Waste plastics
- Recycled metals



Industrial symbioses create synergies reducing resource use across sectors

Gas valorisation
- CO2 Capture and reuse
- Mineralisation
- Heat utilisation

Iron- and steelmaking slags
- Cement and concrete
- Construction
- Agriculture and water management

Dusts, sludges mill scales
- Metal recovery
- Chemical applications

From drivers to solutions in steel sector industrial symbiosis

Drivers

IS is driven by a combination of economic, enviromental and policy factors that encourage cross industry collaboration

- Economic incentives: Cost savings, new revenue
- Policy/environmental pressure supporting Circular Economy
- Proximity and facilitators enable collaboration

Barriers

Despite strong drivers, the implementation of IS is limited by several economic, technical and organizational barriers

- High costs and investment constraints
- Technical, regulatory and data challenges
- Limited trust and collaboration

Solutions

To adress these barriers, coordinated solutions are requiered, integrating technological innovation, collaboration, digital tools and policy support

- Technology and modelling improve efficiency
- Digitalisation enables data sharing, matching
- Policy and collaboration support implementation

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Conclusions

Industrial Symbiosis is a key enabler for improving resource efficiency and reducing emissions in the steel sector through cross-sector reuse of materials and energy.

- Implementation still limited by technical, economic, regulatory barriers
- Overcoming challenges requires coordinated technology, policy, collaboration
- Future progress depends on digitalisation and stronger industrial network
- Circular economy strategies support sustainable steel production

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