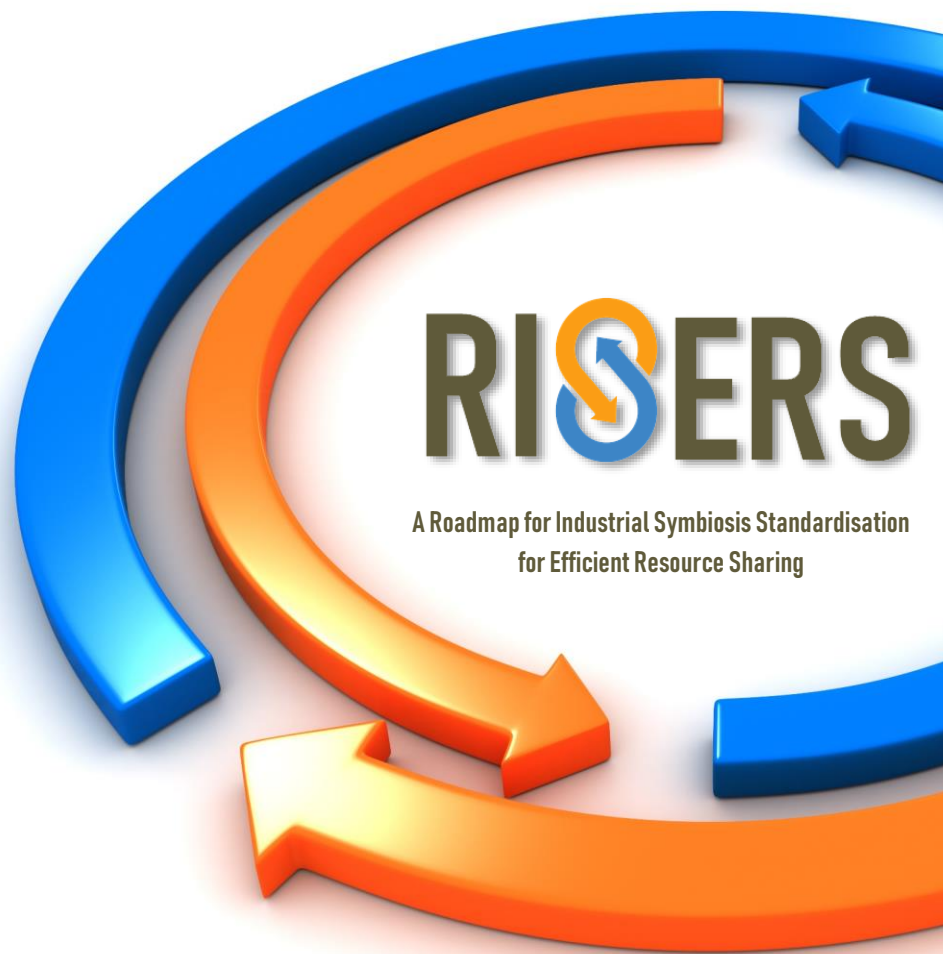




D4.1 MAP OF CURRENT R&I ACTIVITIES RELATED TO THE PRIORITIES FOR INDUSTRIAL SYMBIOSIS STANDARDISATION

THIS DELIVERABLE IS AWAITING FORMAL REVIEW BY THE EUROPEAN COMMISSION
AND MAY BE SUBJECT TO CHANGE.

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*) R — Document, report; DMP — Data Management Plan; DATA — data sets, microdata, etc; DEC — Websites, patent filings, videos, etc

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LIST OF ACRONYMS

Abbreviation	Explanation of abbreviation
ENSPIRE	ENSPIRE SCIENCE LTD
CEN	COMITE EUROPEEN DE NORMALISATION
DIN e.V.	DIN DEUTSCHES INSTITUT FUER NORMUNG EV
EIT-RM	EIT RAW MATERIALS GMBH
Fraunhofer	FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG EV
UGent	UNIVERSITEIT GENT
IETU	INSTYTUT EKOLOGII TERENOW UPRZEMYSLOWIONYCH
ISQ	INSTITUTO DE SOLDADURA E QUALIDADE
ISL	INTERNATIONAL SYNERGIES LTD
CE	Circular Economy
CCU	Carbon Capture and Utilisation
CFC	Circular Floor Covering
CRM	Critical Raw Materials
CSA	Coordination and Support Action
CWA	CEN Workshop Agreement
DPP	Digital Product Passports
EAF	Electric Arc Furnace
EoW	End of Waste
IA	Innovation Action
ICT	Information and Communication Technology
IP	Intellectual Property
IS	Industrial symbiosis
ISO	International Organization for Standardisation
LCA	Life Cycle Assessment
NSB	National Standardisation Body
PPP	Public-Private Partnership
PVC	Polyvinyl chloride
R&D	Research and Development
R&I	Research and Innovation
RIA	Research and Innovation Action

SDO	Standards Developing Organisation
SRM	Secondary Raw Materials
TCs	Technical Committees
WP	Work Package

EXECUTIVE SUMMARY

This deliverable, **D4.1 – Map of Current R&I Activities Related to Industrial Symbiosis (IS) Standardisation**, provides a comprehensive overview of research and innovation projects that contribute to advancing IS standardisation in Europe. The work addresses a critical challenge: the absence of harmonised standards for industrial symbiosis, which hinders resource-sharing practices across sectors and slows the transition to a circular economy.

Purpose and Scope

The objective of this mapping exercise is to identify projects—both finalized and ongoing—that integrate standardisation activities relevant to IS. These insights will inform the RISERS roadmap for IS standardisation and guide future policy and research priorities.

Key Findings

- **Projects Reviewed:** Over 150 projects were screened; 21 were identified as highly relevant (17 finalized, 4 ongoing).
- **Focus Areas:** Each project was analyzed across three dimensions—**Standards, Technologies, and Policies**—to capture their contributions to IS standardisation.
- **Major Trends:**
 - Growing need for harmonised standards in waste flow characterization, end-of-waste criteria, and digital tools such as Digital Product Passports.
 - Strong alignment between IS standardisation and EU policy drivers, including the **European Green Deal** and **Circular Economy Action Plan**.
 - Increasing role of digital technologies (AI, IoT, cloud platforms) as enablers for resource efficiency and symbiotic exchanges.

Strategic Insights

Standardisation is not merely a technical requirement—it is a key enabler for scaling industrial symbiosis. Common standards foster trust, legal compliance, and interoperability, while reducing systemic barriers. However, gaps remain in areas such as life cycle assessment harmonisation, cross-sector data exchange, and standards for innovative materials derived from waste streams.

Next Steps

The findings of D4.1 will feed into **Task 4.2**, which aims to define research and innovation priorities for IS standardisation. This will include:

- Cross-analysis of identified projects against priority synergies.
- Development of recommendations for future R&I funding calls to address standardisation gaps.
- Engagement with standardisation bodies and policymakers to accelerate adoption.

1 INTRODUCTION

Industrial symbiosis (IS) offers significant potential for advancing resource efficiency and sustainability across sectors. However, the absence of harmonized standards and the complexity of cross-sectoral collaboration present substantial barriers to the widespread adoption of IS practices. The RISERS project is dedicated to overcoming these challenges by developing a comprehensive roadmap for IS standardisation. This roadmap aims to streamline resource transactions and facilitate the integration of new research and innovation (R&I) outcomes into industrial symbiosis frameworks.

A central objective of RISERS is to accelerate the uptake of R&I results in IS standardisation. To achieve this, the project identifies demand-driven priorities, as well as the barriers and enablers that influence the market entry of innovative IS solutions. Work Package 4 (WP4) plays a pivotal role in this process by mapping current R&I activities and defining the standardisation needs that will shape future directions. The insights generated by WP4 will directly inform the development of the RISERS standardisation roadmap, which is the focus of Work Package 7 (WP7).

Deliverable D4.1, associated with Task 4.1, provides an inventory of R&I projects and activities that are relevant to advancing IS standardisation and promoting resource circularity. This inventory draws on case studies of projects with pre-standardisation activities, as well as consultations with key initiatives such as A.SPIRE and H4C COP, whose mapping activities and databases have enriched the project's knowledge base. Participation in multiple IS and Circular Economy (CE) workshops and webinars further expanded the pool of potential cases considered.

The mapping process encompassed a review of over 150 projects—both completed and ongoing—related to IS and CE. Projects were selected using “standards” and “standardisation” as primary criteria, and each was assessed from three perspectives: standards, technologies, and policies. This multidimensional approach enabled RISERS to construct a comprehensive overview of the current IS standardisation landscape, drawing on both finalized and ongoing R&I efforts.

For ongoing projects, RISERS adopted a proactive approach by directly engaging with project coordinators to obtain the most current insights, especially when public deliverables were unavailable. This ensured that the database supporting this deliverable reflects the latest developments and planned activities in IS standardisation.

It is important to note that the purpose of this deliverable is not to provide an exhaustive mapping of all reviewed projects. Instead, it offers a detailed account of those initiatives identified as most promising in terms of their contributions to IS standardisation. Projects not included here will be revisited in future tasks to ensure that the RISERS roadmap remains comprehensive and up to date.

No intellectual property rights (IPR) obstacles were encountered during this mapping exercise. Information on finalized projects was sourced from public deliverables and reports, while data on ongoing projects was provided directly by coordinators following RISERS

outreach. Should new material related to IPR issues emerge, it will be addressed in subsequent project phases.

In summary, this mapping task led to the identification of 21 projects (17 finalized and 4 ongoing) with activities or outcomes relevant to IS standardisation. The following sections of this deliverable present key findings from these projects, highlighting their contributions in terms of standards, technologies, and policy recommendations.

2 FINALISED PROJECTS

This chapter presents the key outcomes of industrial symbiosis (IS) standardisation activities identified in 17 finalized projects. These projects were selected based on the relevance and quality of information found in their official reports and deliverables, as well as their impact and contribution to IS standardisation research. All content included in this section is original and sourced directly from publicly available reports and official project websites. (The remaining four ongoing projects are discussed in Chapter 3).

2.1 SCALER

The SCALER project aimed to increase the uptake of IS across Europe by developing a set of best practices, tools, and guidelines, helping businesses and industrial sites work together to ensure sustainable resource use. This project was executed between November 2017 and October 2020 under the CSA funding scheme.

The "Report on industrial symbiosis standardisation needs" [1] from the SCALER project, provides a comprehensive overview and analysis of standardisation aspects related to IS and resource efficiency, particularly in the process industry. It reviews existing standards, frameworks and proposes standardisation actions to address identified gaps in the European context.

2.1.1 STANDARDS

The report describes CEN-CENELEC as a key body in setting common standards across the European Single Market, bringing together national standards agencies from 34 countries. Moreover, CEN-CENELEC also collaborates closely with the International Organization for Standardisation (ISO).

In this report, a total of 46 published CEN-CENELEC standards were analysed, covering concepts, activities, methodologies, reporting practices, and assessments embedded in production systems for the CE. These standards include aspects such as reduction (e.g. eco-design), separation, recycling, recovery, remanufacturing, reconditioning or refurbishing, maintenance and repair, reuse, incineration, and landfill. Most of these standards are defined for specific industrial sectors or materials, with approximately 30% focusing on plastics. A smaller number apply across all sectors, focusing on specific phases of a product's life cycle.

The SCALER deliverable assembled a collection of 286 national and international published standards relevant to IS in the process industries. These relate to sustainable operations, innovative material and energy use, waste stream reuse and recycling, sustainable product design, digital transformation technologies, and sustainable finance instruments. Approximately 85% of these standards have an impact at the firm/industry level ('Micro'), 10% at the national, European, or global level ('Macro'), and 5% at eco-industrial park or regional development level ('Meso').

2.1.2 TECHNOLOGIES

The report emphasizes the role of digital transformation technologies as key enablers for achieving CE and smart manufacturing objectives. Technologies such as artificial intelligence, 5G, cloud computing, big data, robotics, 3D printing, and the Internet of Things are recognized as crucial for resource efficiency, smart manufacturing and accelerating climate action and environmental protection.

In smart manufacturing, standards are needed for distributed manufacturing services to close resource loops. This includes requirements for integrating manufacturing resources and capabilities into cloud-based manufacturing service platforms.

For data interfaces in circular economy platforms, the report highlights the need for standards on data collection, coding formats, and information exchange requirements within industrial parks.

2.1.3 POLICIES

The document connects standardisation efforts with major European policies and highlights the need for policy-supportive standards. The key policies referenced include:

- European Green Deal, which aims to transform the EU into a climate-neutral and CE, decoupling economic growth from resource use, and is a major driver for standardisation. The success in achieving the ambitious goals of the Green Deal requires the consistent use of all policy levers, including regulation and standardisation, investment and innovation, national reforms, dialogue with social partners, and international cooperation. This report affirms the current lack of requirements to ensure that all products placed on the EU market become increasingly sustainable and stand the test of circularity.
- EU Circular Economy Action Plan to modernize Europe's economy by keeping resources in the EU economy longer, stimulating lead markets for circular products, transforming consumption patterns, and encouraging durable, repairable, and reusable products. This report presents digital passports, tagging, and watermarks as solutions to provide accurate data reflecting the environmental, social, and economic impacts of products and processes, which is supported by new standards.
- EU Green Bond Standard to explore a voluntary, non-legislative standard to enhance the effectiveness, transparency, comparability, and credibility of the green bond market, including alignment with EU taxonomy. This report proposes the creation of new standards focused on Green Bonds, which can support and incentivise the necessary capabilities and knowledge for the EU Green Deal strategies.

2.2 SYMBIOPTIMA

SYMBIOPTIMA developed an integrated Energy and Resource Management System, which offers tools for production plants scheduling, demand response management and for Life Cycle Sustainability Assessment. This project was executed between September 2015 and February 2019 under the RIA funding scheme.

One of the outcomes of this project was the report named “Standardisation Framework contribution to support circular economy” [2]. This document outlines a standardisation framework for IS within the broader CE context, as discussed below. The document promotes the reuse and recycling of resources to minimize waste and support sustainable economic growth.

2.2.1 STANDARDS

This deliverable clarifies relevant aspects for promoting standardisation to support circular symbiosis. The development of new standards is also mentioned to link policies and regulations at all levels, playing a significant role in reinforcing trends introduced by policymakers. The primary purpose of standardisation activities, in this context, is to identify quantitative criteria for symbiosis processes to help companies conduct internal audit activities that address both symbiosis activities and environmental concerns.

Standardisation is described as a driver for reducing economic, social, regulatory, informational, technological, environmental, and structural barriers to symbiotic activities. For instance, it may help to reduce economic risks, increases transparency and trust among partners and local communities, verifies legal compliance, facilitates information exchange, formalizes technical alternatives and limits, assesses environmental impacts, and helps overcome geographical limitations for network extension.

The report also identifies legislative constraints that influence the evolution of standards, especially within product supply chains and waste management. Anticipated operational trends in standardisation include:

- **Waste flow characterization** for achieving the necessary level of detail/information for waste flow re-utilization.
- Create a **European Waste Catalogue** for a better adoption of harmonised nomenclature for "secondary raw materials".
- **Trans-sectoral approaches** to overcome the current product-centric approach. There is a lack of specific actions for individual industries or recognition of diverse symbiotic network peculiarities.

2.2.2 TECHNOLOGIES

The document's reference to technological aspects is limited. There is a mention of a process called Smart Production Units based on a human-mimetic approach to integrate monitoring, management, and optimization across a symbiotic cluster.

2.2.3 POLICIES

The document emphasizes the significant role of policies and regulations in driving standardisation for IS and the CE. This includes the *Eco-design Working Plan* (2016-2019) containing specifications on durability, reparability, and recyclability of products.

The *Restriction of Hazardous Substances Directive* is also described in this report, mainly for the replacement of hazardous materials in new products to make component recycling more profitable and safer.

Moreover, the *Directive on Packaging and Packaging Waste* (COM/2015/0596) specifies definitions on recyclable quantities for packaging and recovery targets by material type.

2.3 REHAP

The main objective of REHAP was the transformation of agroforestry residues into new sustainable and eco-efficient derivatives such as building blocks, high-performance additives and biobased polymeric resins and to demonstrate their potential use in several products at an industrial level in sectors such as construction. This project was executed between October 2016 and March 2021 under the IA funding scheme.

This document, "Measures for future standardisation of the biobased products" [3] outlines a systemic approach to reduce energy demand and CO₂ emissions by transforming agroforestry waste into high-value bio-based products. It focuses on standardisation aspects rather than production processes, providing internationally recognised guidelines to achieve sustainability targets for both processes and products.

2.3.1 STANDARDS

The deliverable identifies key aspects for product standardisation including the sustainability of raw materials, bio-based content, and recyclability (circularity). It also outlines the development of standards for horizontal aspects of bio-based products, covering terminology, sampling, certification tools, bio-based content, Life Cycle Assessment (LCA) application, sustainability criteria for biomass and final products, and bio-solvents.

In terms of plastic compounds, the document provides requirements for the declaration, statements, and labels concerning the bio-based carbon content of polymers, plastic materials, semi-finished products, and composites.

Sustainability criteria were also implemented for the bio-based products (excluding food, feed, and energy), covering environmental, social, and economic aspects. It establishes criteria and indicators for organisations to address, providing a framework for managing sustainability aspects rather than claiming absolute sustainability. It requires documentation of data, information sources, assumptions, and the type/origin of primary or secondary biomass feedstock.

2.3.2 TECHNOLOGIES

The document refers to environmentally friendly technologies in a general and systemic approach to reduce energy demand and CO₂ emissions of processes that transform agroforestry waste into high added value products. However, the report itself does not detail specific new technologies developed by REHAP, focusing instead on the standardisation aspects of the resulting products and processes.

2.3.3 POLICIES

One of the broad objectives of this project is to guide policy makers. However, this document itself does not describe any specific policy outputs or proposed policy recommendations resulting from the project's work. Its focus is primarily on providing guidance through standards for REHAP's internal operations (valorising agroforestry residues) and product development to achieve sustainability targets.

2.4 HARMONI

HARMONI aimed to bring together all relevant stakeholders across the process industry to jointly identify, analyse and propose solutions to regulatory bottlenecks and standardisation needs that hamper their innovation processes and limit the market uptake of their results. This project was executed between August 2017 and October 2019 under the CSA funding scheme.

This deliverable concerning IS standardisation [4] gathered insights on non-technological barriers impacting the deployment of innovative solutions in areas such as resource efficiency, CE, and energy. The collected remarks were intended to cover regulation, standardisation, and other non-technological hurdles.

2.4.1 STANDARDS

Standardisation is a key focus area of the HARMONI project, alongside regulatory bottlenecks and other non-technological barriers. The project sought to identify and prioritize standardisation needs relevant to industry, end users, and policymakers.

New technologies, research results, and knowledge were integrated into standardisation within the existing framework. Project outcomes (technology scale-up, material valorisation and market exploitation) can also be "tested" with a wide community of stakeholders, increasing awareness and expanding networks. They also contribute to increasing competition and export potential.

The interviews performed during this task revealed that standards are seen as powerful tools for boosting and exploiting EU project results, particularly beyond the project execution phase. However, the standardisation process is typically lengthy, suggesting that the proposal of a new standard often occurs after a project's completion.

A need was identified to support data sharing through potential standardisation measures. A proposal to encourage greater participation and involvement of policy makers in Technical Committees (TCs) was made. Industry participants are recognized as powerful and active voices in national standardisation committees, perceived as enablers and predictors of future technical trends, and their role, in conjunction with final users, is encouraged to be tracked and supported in TCs.

The report highlights the need for guidelines to address the complexity and variability that leads to a lack of homogeneity and a holistic overview in standardisation for IS. It was reviewed the importance of product and process driven standards, especially in cases involving new materials derived from recovered waste, where standards are considered a

powerful tool. The urgency in increasing the support for external industrial consulting experts in the development of standards is emphasised, as their limited presence is delaying progress on many standards.

2.4.2 TECHNOLOGIES

The document refers to LCA methodologies. It suggests developing or aligning guidelines for LCA that could facilitate a broader use of broadly accepted procedures, hinting at a standardisation need or opportunity for LCA.

The project also aims to facilitate the deployment of available or very close to the market promising technologies (related to advanced renewable fuels production, and minerals/metals recovery) in the process industry. It seeks to identify new ideas and the possible transfer of a new technology from one sector to another to reach critical mass for advanced and breakthrough technologies.

2.4.3 POLICIES

The deliverable notes that regulatory distortion generates unfair competitive conditions across countries. Engineering companies, which must comply with EU and international regulations, experience these inconsistencies firsthand when working with end users.

The project advocates for stronger harmonisation of European waste, water, and energy policies. It is important to link initiatives at national and regional levels, covering capacity building, investment, education, and training. Interviews revealed concerns about contradictory positions from different interested parties regarding changes to the Waste Directive, which complicates the situation but also illustrates the power of incentives.

There is a recognised need for a more transparent procedures in setting targets within EU directives and for improving information tracking and bidirectional communication channels (private to public). Concerns about distortions in certain regulations (e.g., energy directive transposition into Member States) were raised. A new approach to IS concepts and their integration within regulatory frameworks is urged.

The report declares the integration of regulatory analysis at a very early stage of technology development. Existing regulations should be adapted to a broader CE approach, using this shift as an enabler for necessary changes.

The involvement of regional/national regulatory policy makers in regulation development is also suggested to include expertise and practical knowledge. Interim incentives are worth exploring to complement the waste directive and circular economy package to boost cost-effective technologies and business cases.

2.5 REMADYL

The REMADYL project tackled the problem of removing the additives and deliver high-quality compliant Polyvinyl chloride (PVC) through a single-step continuous process. The project produced new products from the recycled PVC while safely disposing of hazardous

plasticisers and reusing the lead in batteries. This project was executed between June 2019 and November 2023 under the RIA funding scheme.

The “Policy & Standardisation input” document [5] focuses on policy challenges and recommendations to improve decontamination and recycling processes in plastics, and create clear, stable legislation to encourage sustainable practices and traceability of substances in new products.

2.5.1 STANDARDS

The document notes that certain product standards set requirements beyond what is necessary for required performance, which can exclude the use of recyclates. Therefore, careful review and adjustment of such standards is needed to encourage recycled materials incorporation.

REMADYL emphasises the successful use of recyclates in market-ready products with defined performance standards and pays careful attention to product standards that might unnecessarily exclude recyclates.

It has proposed several standardisation insights to support a safe and circular economy for plastics. It is crucial to create clear and aligned EU-wide definitions for the recycling yield of input streams and the recycled content of output streams for new recycling technologies that follow physical material flows.

When substituting hazardous substances, alternative additives must meet specific conditions in the standardisation context: proven safety, effective sorting from waste streams (equal or higher level than the replaced substance), or constrained use in specific product categories with established cradle-to-cradle recycling.

2.5.2 TECHNOLOGIES

The REMADYL project shifted from a continuous extractive extrusion process towards developing and scaling up a batch or semi-continuous extraction process, offering higher flexibility in pressure and extraction time. This process is based on extractive extrusion technology combined with innovative solvents and melt filtration to remove hazardous plasticisers and contaminants more effectively.

2.5.3 POLICIES

REMADYL presents some policy recommendations categorised into three main topics:

1. Supporting market uptake of plastic recyclates,
2. Ensuring a stable legislative environment, and
3. Guaranteeing a safe circular economy for plastics.

Policies should consider both the quality of recycling and final application when setting recycling rates and recycled content targets, complemented by measures that encourage high-quality recycling.

It encourages legislative initiatives to create, modify, or reinforce recycling processes that can effectively eliminate legacy additives, and it supports waste collection schemes across Europe to streamline waste exchange and optimize recycling efficiency.

This report also considers financial incentives for the use of plastic recyclates (e.g., price or tax reductions), compensating investments for adapting production processes, and offering subsidies for improved sorting lines and purifying technologies.

Future legislative initiatives should aim to eliminate the necessity for decontamination processes by continuously encouraging design for recycling from a chemical perspective, considering end-of-life scenarios.

The EU Commission should also allocate funds to support academic research on developing alternative additives to replace harmful substances in plastics and support the establishment of EU-wide standards for analysing wastes to identify classified substances.

2.6 SHAREBOX

SHAREBOX developed a secure platform for the flexible management of process resources that provided plant operations and production managers with robust and reliable information in real-time in order to effectively utilise resources (plant, energy, water, residues, and recycled materials) from other companies in a symbiotic industrial eco-system. This project was executed between September 2015 and August 2019 under the RIA funding scheme.

The standardisation outcome of this report (CEN Workshop Agreement for industrial symbiosis) [6] addresses the confusion caused by varied terminologies in existing policies and seeks to promote a sustainable resource use and a CE by turning one industry's underutilized resources into another's valuable inputs.

2.6.1 STANDARDS

The primary standardisation output proposed and developed is the CEN Workshop Agreement (CWA) for industrial symbiosis. The CWA was initiated to address the variety of confusing and sometimes misleading terminologies and methodologies used for IS in European Commission documents and Member States.

The CWA provides consensus on core elements of IS to enable its identification. These include returning underutilised resources to productive use, requiring information about opportunities, and establishing business conditions that incentivise IS.

The CWA explicitly references several standards and related documents that are central to its content (Table 1).

Table 1: CWA standards and related documents (SHAREBOX project)

Document	Topic
BS 8001: 2017	Guidelines to a Circular Economy.
IWA 27: 2017	Guiding principle and framework for the sharing economy.

2008/98/EC	Directive of the European Parliament and of the Council of 19 November 2008 on waste.
2012/27/EU	Directive of the European Parliament and of the Council of 25 October 2012 on energy efficiency.

2.6.2 TECHNOLOGIES

The document highlights the role of Information and Communication Technology (ICT) in supporting IS, though it notes that initial passive online waste exchanges had limited success due to their inability to meet specific industrial information needs. The reason was the lack of crucial information available regarding classification, contamination, distribution and timing issues. ICT (software) is also recognized as crucial for data management and impact tracking to overcome information barriers in industrial symbiosis.

The CWA outlines good practice implementation steps for IS:

- Full characterising resources available (including waste, by-products, residues, energy, water, logistics, capacity, expertise, equipment, and materials) and reassessing waste for its value as a resource.
- Identifying and assessing opportunities to return underutilised resources to productive use. This often requires cross-sector knowledge, as most reuse opportunities are found outside an organization's own sector.
- Matching available resource with the appropriate opportunities. This step requires addressing technical, economic, and legal requirements, and may also require intermediate transformation steps.

2.6.3 POLICIES

The document extensively addresses the interaction between IS and policies. As an example, the 2018 Amendment to the Waste Framework Directive (2008/98/EC) mandates Member States to promote sustainable use of resources and IS. Also, the CWA itself is intended to form the basis for policy, recommendations, and widespread implementation of IS.

Moreover, it listed multiple EU directives and policy documents that mention IS in relation to resource efficiency, including amendments to directives on "Landfill Waste" and "Packaging Waste", as well as various communications and roadmaps.

Policy enabling contexts are highlighted as crucial, meaning policies should not introduce legislative or regulatory barriers, but rather incentivize IS.

2.7 CIRCPACK

CIRCPACK developed breakthrough biodegradable plastics using alternative bio-based raw materials and eco-friendly packaging designs adapted to these plastics to improve collection and recycling. This project was executed between May 2017 and June 2020 under the IA funding scheme.

The document, "Report on the contribution to standardisation and measures for future standardisation of the biobased products" [7] summarises standardisation efforts during the project, and details the methodology used to identify links with existing standards. It concludes with recommendations for future engagement with standardisation, particularly emphasizing participation in initiatives related to CE metrics.

2.7.1 STANDARDS

The CIRCPACK project made an extensive use of various existing standards, primarily for the characterization of materials and products. Specific standards referenced are present in **Table 2**.

Table 2: Standards referenced in CIRCPACK project

Standard	Topic
EN 16785-2	Determination of the bio-based content using the material balance method (this standard was published and highlighted as an example of updated information on standardisation activities).
EN 13432	Compostability and biodegradability.
ISO 9001	Quality management system.
ISO 14001	Environmental management system standard (mentioned as a standard implemented by organizations).
ISO 14020	Life-cycle analysis for value chain evaluation, which also sets indicators that could be standardised.
ISO 22391-1	Use of polyethylene of raised temperature in plastic piping systems.

Table 2 shows that test methods for characterizing new biodegradable bio-based polymers, such as tests for biodegradability, organic carbon determination, and physical/chemical properties, are already standardised.

2.7.2 TECHNOLOGIES

This project optimized the combination of sensors, automatic devices, applications, and data flows within the extrusion transformation process. From a standardisation perspective, this process is considered very unlikely to be standardised, since it optimises a process.

A recovery process for tetrahydrofuran was also developed. This represents a process for recovering a specific chemical. Therefore, it has a very low potential for standardisation because standardising products is more common than standardising processes.

2.7.3 POLICIES

No relevant information or data linked to policies was identified in this deliverable.

2.8 RETROFEED

RETROFEED's main objective was to increase the use of bio-based and circular feedstock in process industries through the retrofitting of core equipment and the implementation of an advanced monitoring and control system covering the production chain. This project was executed between November 2019 and October 2023 under the IA funding scheme, and it involved the participation of six demonstration sites (TORRECID, SECIL, ASAS, FERRIERE NORD, TENARIS SILCOTU and FERTIBERIA).

The report "Policy recommendations based on the results of the regulatory & standardisation analysis for RETROFEED promotion and replication" [8] provides a comprehensive regulatory assessment, examining European and national legislation (e.g. Europea Green Deal, Waste Framework Directive and Carbon Border Adjustment Mechanism) related to technical norms, energy, health, safety and environment regulations. It also itemizes standards applicable to several industrial sectors.

2.8.1 STANDARDS

The analysis of national and European standardisation and technical normative issues is a foundational element of the report. Alongside this, the regulatory assessment is essential for developing RETROFEED interventions and forming the basis for replication operations in other industrial sites. The project's efforts are intended to contribute to the EU ongoing procedures of standardisation and regulation.

The methodology utilised a structured questionnaire circulated among project partners to identify and collect the relevant standards and regulations already in place at each demonstration site. The questionnaire also investigated whether the demo sites had already liaised with any Standards Developing Organisation (SDO), National Standardisation Body (NSB), or TCs.

Regarding the specific technical, quality, health, safety and environment standards, particular attention was given to the following demo sites:

- Aluminium sector: ISO 45001 (occupational health and safety management systems), EN 15530 (environmental aspects of aluminium products) and EN 12258-1 (scrap standards).
- Cement sector: EN 197-1 (composition and specifications for cements), EN 196-11 (testing cement methods), CEN/TR 16912 (guidelines for standardisation of cements) and EN 16908 (environmental product declarations).
- Ceramic sector: EN 14411 (ceramic tiles definitions and classification) and EN ISO 10545-1 (ceramic tiles covering sampling).
- Fertilizers sector: ISO 18644:2016 (fertilizers and soil conditioners - general requirements).

These standards were important for RETROFEED's innovation area by contributing for some technological improvements as described in the next subchapter. By aligning with existing initiatives and standards in the future, RETROFEED solutions will be easier to implement and

replicate with the industrial processes in the targeted industries, enabling better process optimisation, resource efficiency, and reduced environmental impact.

2.8.2 TECHNOLOGIES

The core technological output of RETROFEED involves implementing a smart retrofitting framework using advanced digital tools and physical modifications to core equipment. Digital twins were developed for process control in energy-intensive industries (e.g. melting furnace simulations, oxygen injection system and mass/energy balance models).

In the ceramic sector the output was a high temperature exchanger for combustion air designed to reduce CO₂ emissions by 15%, as well as novel sensors to further reduce greenhouse emissions.

For the cement sector, the result was the design of a new main burner for the rotary kiln that can accept a higher percentage of alternative fuels.

In addition, the fertilisers sector installed a reactor to save at least 50 kg of steam per tonne of product and allow the use of alternative sources of phosphorus within a CE approach.

2.8.3 POLICIES

For the success and replicability of RETROFEED innovations, policy makers should establish a legal framework based on the following principles:

- **Reducing administrative barriers:** future creation and evaluation of European legislation must guarantee coherence and efficiency, reduce administrative barriers, and include appropriate implementation timeframes.
- **Stakeholder inclusion:** stakeholders must be included in the consultation process to implement regulations "with industries, not against them".
- **The "Innovation Principle":** creating a framework that supports industry innovation and removes existing obstacles to attract investments.
- **Financial support and Intellectual Property (IP) reform:** implementing a framework for reforming IP and offering financial support and incentives for R&D.

2.9 FISSAC

The overall objective of the FISSAC project was to develop and demonstrate an innovative IS model to support a zero-waste approach in the resource intensive industries (ferrous and non-ferrous metals, cement, ceramic, natural stone and chemicals) across the construction value chain. This project was executed between September 2015 and February 2020 under the IA funding scheme.

The "Report on the contribution to the standardisation System regarding FISSAC technologies" [9] outlined a strategy for standardisation, including coordination with relevant TCs and the identification of standardisation fields of interest for the FISSAC project, particularly concerning materials and construction products.

2.9.1 STANDARDS

Standardisation efforts in FISSAC involved collaboration with European (CEN, CENELEC) and International (ISO) standardisation bodies. The project analysed standardisation activities across several key material groups.

The most relevant standard identified for cement was the EN 197-1 (composition, specifications and conformity criteria for common cements).

The core standard for concrete was the EN 12620 (aggregates for concrete).

For the ceramic sector, the EN 14411:2016 (ceramic tiles - definitions, classification, characteristics) was highlighted as a key standard.

For wood plastic composites EN 15534-1 (test methods for characterisation of compounds and products) was identified as the most relevant.

FISSAC developed a calcium sulpho-aluminate cement (low carbon cement) and binary cements incorporating new additions derived from waste.

These products are not covered by existing standards such as EN 197-1. As a result, future standardisation proposals for new binary and sulpho-aluminate cements will need to be evaluated and developed.

FISSAC also formulated a new green concrete utilising alternative aggregates. The properties of these new aggregates must be assessed against EN 12620 (aggregates for concrete). Since Electric Arc Furnace (EAF) slag is not currently covered in this standard, its revision is expected to include proper consideration of these new sub-products.

All these standards are important for FISSAC technologies, because they help to be aligned with European legislation (particularly in the construction sector), they validate the technical viability and quality of the secondary raw materials, and they reveal current limitations and future standardisation pathways.

2.9.2 TECHNOLOGIES

The FISSAC project involves the development, demonstration, and assessment of new eco-innovative products and the technologies required to produce their associated secondary raw materials (SRM). The report references technologies linked to:

- The use of waste and industrial by-products in clinker and cement production.
- Cement production incorporating ceramic waste, glass waste, and EAF and slag.
- The development of green concrete utilizing alternative aggregates derived from treated EAF slag and glass waste, replacing natural aggregates.
- Replacing clay minerals and calcium carbonate with aluminium salt slag (from aluminium recycling) and marble slurry (from the natural stone sector) during the manufacturing process of ceramic tiles.

2.9.3 POLICIES

FISSAC is directly related to European legislation and strategic policies as shown in **Table 3**.

Table 3: Legislation and policies linked to FISSAC project

Legislation/Policy	Content
Construction Products Regulation (CPR)	Establishes harmonised conditions for the marketing of construction products and defines criteria for CE marking. Most standardisation activities relevant to FISSAC construction products (cement, tiles, aggregates, plastics) support this regulation.
Waste Framework Directive (2008/98/EC)	Provides the framework for waste management, including principles like the "waste hierarchy" and conditions for achieving end-of-waste (EoW) status (Article 6).
Circular Economy Package	Aims to reduce waste generation and promote resource efficiency. FISSAC supports this through IS practices (turning one industry's by-product into another's raw material) and promoting the use of SRM. The package includes specific actions for the construction and demolition sector.
Ecodesign Directive (2009/125/EC)	Sets a framework for ecodesign requirements for energy-related products. Related standardisation outputs are covering topics like extending product lifetime, ability to re-use and recycle materials.

2.10 MEASURE

MEASURE provided support and guidance for European process industries across sectors such as chemistry, consumer goods, steel, automotive, non-ferrous metals, water and waste with profound complementing expertise on sustainability assessment with regulators and standardisation bodies. This project was executed between January 2015 and March 2016 under the CSA funding scheme.

The deliverable "For Sustainability Assessment in European Process Industries" [10] focuses on three core areas: open issues with LCA methodology, difficulties in cross-sectoral collaboration along value chains, and the use of life cycle methods for sustainable process design and innovation. The document also offers recommended actions and R&D needs to improve the harmonisation and effectiveness of sustainability tools for achieving Europe's resource and energy efficiency goals.

2.10.1 STANDARDS

The document frequently references and relies upon established international standards, primarily those related to LCA (ISO 14040/44). They represent a full global stakeholder consensus and provide the widely accepted framework for LCA in several industry sectors.

The roadmap identifies numerous open issues and R&D needs that require urgent standardisation or harmonisation, particularly concerning LCA methods, data structures, and their application within Public-Private Partnership (PPP). Harmonisation of performance indicators and benchmarking approaches is urgently needed for evaluating emerging new technologies.

The MEASURE project recommends developing a documentation standard for information that shall be provided with LCA data to safeguard data recipients against misunderstandings and inconsistencies (like double counting). Good data documentation is critical for cross-sectoral LCA consistency. The use of established metrics is also recommended for evaluating PPP targets, as the rules for calculating these indicators are commonly agreed on and easy to harmonise.

2.10.2 TECHNOLOGIES

The roadmap emphasises the need for specific tools and technological developments to support resource efficiency and sustainability integration into industry innovation. There is a need to couple sustainability assessment approaches with engineering software tools to allow synergies and a holistic understanding of innovation potentials.

Further development of data-mining methods for generic LCA should be enhanced to support early-stage R&D activities. This includes the development of novel energy-saving processes, process intensification, energy recovery, sustainable water management, and the introduction of renewable energy sources.

2.10.3 POLICIES

No relevant information or policy-specific data was identified in this deliverable.

2.11 CORALIS

CORALIS was focused on the execution of real IS initiatives and on overcoming the obstacles faced by these initiatives. One of its main actions addressed technical, managerial and economic factors influencing IS implementation by demonstrating 3 industrial parks (each of them supported by an IS facilitator). This project was executed between October 2020 and March 2025 under the IA funding scheme.

The extensive document found ("Recommendations for the standardisation committees") [11] meticulously analyses the European and national regulatory framework focused on waste management, energy efficiency, and electricity market rules. It identifies key regulatory and standardisation barriers that hinder IS implementation, such as complex permitting processes for new plants and ambiguities in classifying by-products and EoW materials.

2.11.1 STANDARDS

The assessment in this report focused on two main areas for IS standardisation:

1. Energy Management and Energy Efficiency.
2. Exchange of Materials (By-products and wastes).

Material and products used after waste reprocessing must meet all relevant product standards. Quality criteria for EoW materials must be in line with standards applicable to products.

The report recommends developing or expanding existing energy efficiency standards (e.g., ISO 50001) to include guidelines tailored for inter-plant exchanges of energy, water, and materials within industrial clusters. It also advises the creation of measurement methodologies for exchange of materials, energy, water, and by-products to enhance transparency and demonstrate the economic and environmental benefits of IS.

The document also highlights that standardisation drivers include Digital Product Passports (DPPs). DPPs are standardised documents that track a product's lifecycle, material composition, and compliance with environmental regulations, thereby supporting transparency in symbiotic networks.

Furthermore, the report encourages standardisation of batteries and Critical Raw Materials (CRMs) to ensure industries recycle these materials in compliance with environmental standards, promoting closed-loop systems.

2.11.2 TECHNOLOGIES

The report identifies several technologies that are either critical components of IS projects or are drivers for further standardisation (**Table 4**):

Table 4: Relevant technologies identified by CORALIS project

Technology	Description
Carbon Capture and Utilisation (CCU):	A core technology explored within the CORALIS project, specifically the process of recycling from industrial sources for use in horticultural applications (plant enrichment in greenhouses).
Hydrogen Production and Distribution	Hydrogen production, along with e-fuel/bio-fuel production, is recommended for integration into energy management concepts, supporting energy recovery processes.
Heat Recovery and Redistribution Systems	These include high-efficiency cogeneration units for electricity generation district heating and cooling networks used to transfer surplus waste heat/cold between industries or to nearby communities.
Thermal Storage and Heat Pumps	Thermal storage is highlighted as important for the economic operation of heating networks, particularly when combined with large-scale solar thermal plants. Heat pumps powered by renewable sources (like rivers and air) are also considered essential for district heating and decentralized uses.
Waste-to-Energy Systems	These technologies such as waste-to-energy systems are mentioned for integration into comprehensive energy management concepts.

2.11.3 POLICIES

Key outputs stemming from EU and national policy frameworks influencing IS include definitions, specific requirements, and enabling policies:

- **Waste hierarchy:** Established the priority order for waste management: prevention, preparing for re-use, recycling, other recovery, and disposal.
- **By-product status:** Defines criteria when a substance resulting from a production process is considered a by-product, not waste (e.g., certainty of use, produced as an integral part of the process, used directly without further processing beyond normal industrial practice, and lawful use). The European Commission may adopt implementing acts to establish detailed criteria for the uniform application of by-product status, prioritising replicable IS practices.
- **EoW status:** Specifies when waste ceases to be waste after recycling or recovery operations (e.g., meeting technical requirements, demonstrating market demand).
- **Guarantees of Origin:** Certify the renewable origin of electricity, enhancing energy market transparency.
- **Renewable Energy Communities:** Enable industries to collaborate on green energy production and consumption projects for facilitating collective benefits.

2.12 LIGHTME

The LightMe project targets the setting up of a self-sustainable open innovation ecosystem for the upscaling of industrial processes concerning lightweight metal alloys (aluminium, magnesium and titanium) composites. The LightMe Ecosystem provided the necessary infrastructure (6 Pilot Lines) and knowhow for upscaling advanced materials in a cost effective and sustainable way. This project was executed between January 2019 and June 2023 under the IA funding scheme.

A dedicated report on Ecosystem's liaison with standardisation bodies [12], focused on lightweight metal matrix nanocomposites and its six Pilot Lines, with current standardisation developments. The report details the consortium partners' existing liaisons with standardisation organizations such as ISO and CEN, particularly concerning additive manufacturing.

2.12.1 STANDARDS

The LightMe Ecosystem includes nano safety, regulation, and standardisation services as one of its fundamental building blocks. The project makes the alignment of the Ecosystem with the most recent standardisation developments concerning applications, sectors, and processes.

It also provided high-level consultancy concerning regulations and standards to ensure alignment with upscaling standardisation activities, latest best-practices, and specific applications. Their activities promoted discussions on advancements in lightweight materials and providing suggestions for amendments on current standards or the need to develop new ones, such as:

- ISO TC 261 (additive manufacturing).
- ISO/TC 306 (foundry machinery focus on casting process).
- ISO 1874-2:2006 (laser sintering).
- ISO 4492:2017 (metallic powders compacting and sintering).

Many standards are lacking for the additive manufacturing field, requiring partners to rely on their experience and material characterisation. There is also a need for standards on inspection testing in additive manufacturing, mainly in sectors like aeronautics or automotive.

2.12.2 TECHNOLOGIES

The LightMe Ecosystem developed in this project boosts the lightweight metals infrastructure and their applications, specifically in the field of lightweight metal matrix nanocomposites. The project specifically focused on the advancements in the additive manufacturing industry.

2.12.3 POLICIES

We could not find any relevant information or data linked to policies in this deliverable.

2.13 STAN4SWAP

The EU project Stan4SWAP focuses on standardisation for swappable batteries in light-category electric vehicles. It offers a comprehensive overview of the standardisation landscape, including the principles of standards, the roles of European and international organizations, and the economic benefits of standardisation like cost reduction and interoperability. This project was executed between December 2023 and November 2025 under the CSA funding scheme.

The “Handbook on Standardisation for mobility and transport in the batteries ecosystem” [13] discusses the challenges and strategies involved in transnational standardisation, such as addressing cultural differences and managing negotiation conflicts. Furthermore, the handbook provides guidance on linking research and development with standardisation efforts to support the safe and efficient adoption of battery-exchange systems.

2.13.1 STANDARDS

The batteries ecosystem relies fundamentally on standards to ensure interoperability (the capability to transfer power and/or data among various swappable battery systems, vehicles, and swap stations without modification) and compatibility (the capability of battery systems to meet requirements of stations and vehicles to transfer energy and exchange data without adverse consequences). Standards must ensure a consistent level of safety and security performance across components, specifically regarding data exchanges and interfaces.

A key strategy is to focus on collaboration with other standardisation projects and initiatives. Standards should focus on setting performance targets (firm values or ranges) and should only prescribe explicit technical solutions in exceptional cases, promoting competition and market sustainability.

Strategies to reduce interoperability problems include clarification of options, validation of standards implemented in products prior to implementation, development of reference guides, and interoperability testing. Standards should support component innovations and facilitate the extension of the swappable batteries ecosystem to use cases beyond light vehicles.

In this deliverable, the standardisation process is crucial for establishing the necessary consistency, reducing costs, guaranteeing quality, and ensuring interoperability, acting like a common language for technology developers to ensure all parts of the battery ecosystem stations can communicate and function seamlessly together.

2.13.2 TECHNOLOGIES

In this project, the core technology is swappable battery for light category electric vehicles. However, the purpose of this project was not to develop technologies but standards. Therefore, we could not obtain any relevant information or data linked to technologies during our consultation.

2.13.3 POLICIES

The Stan4SWAP project aims to provide appropriate contributions to the following Europe's regulatory framework:

- EU 2023/1542 (Battery Regulation): Proposal that compliance with the standard could be considered the sole criterion for the definition of the battery type for standardised batteries.
- EU 2023/1804 (Alternative Fuels Infrastructure Regulation): This regulation should refer to standardised battery swapping stations, including minimum requirements for the density of the network.
- EU 168/2013 (L-cat Vehicle Type Approval): Standards may facilitate an amendment to allow vehicle type approval without including a specific propulsion battery.

2.14 BIOMAC

BIOMAC [14] is a project that established a true collaborative ecosystem where technologies and solutions utilising nano-enabled bio-based materials (from biomass fractionation to intermediate chemicals) are upscaled and prepared for market applications (automotive, agricultural, food packaging, construction and printed electronics industries). The ambition of BIOMAC is to raise and sustain innovation in the field of European bio-economy industries, by reducing the time-to-market of novel nanotechnologies, thus reducing cost and risks. This project was executed between January 2021 and June 2025 under the IA funding scheme.

This project ended recently (June 2025); therefore, at the time of writing this deliverable, no outcomes related to IS standardisation were yet accessible or published. The following information was kindly and freely provided by a project member after our contact and consultation.

2.14.1 STANDARDS

The BIOMAC roadmap for the development of standards is focused on the following areas:

- Controlling occupational exposures to nanomaterials.
- Determining relative toxicity and hazard potential of nanomaterials.
- Ensuring product safety of nanomaterial products.

- Environmental uses for nanomaterials.
- Toxicological screening of nanomaterials.

The aim is the development of several standardisation deliverables focused on the following areas:

- Methodologies for nanomaterials characterisation in manufactured form and prior toxicity and eco-toxicity testing.
- Sampling and measurement of exposures to nanomaterials.
- Methods to simulate exposures to nanomaterials.
- Guidelines on nanoparticles and other nanoscale entities, including occupational handling and exposure (dosimetry and exposure determination, detection, and identification).

The internal BIOMAC workshop on standardisation included specific tasks for:

- Classification, terminology and nomenclature.
- Metrology and instrumentation (including specifications for reference materials).
- Test methodologies, modelling and simulation.
- Health, safety and environmental practices in nanotechnology products and processes.

2.14.2 TECHNOLOGIES

We could not obtain any relevant information or data linked to technologies during our consultation.

2.14.3 POLICIES

We could not obtain any relevant information or data linked to policies during our consultation.

2.15 ECO-BINDER

ECO-Binder implements industrial R&D activities based on the results of previous research, demonstrating the possibility of replacing cement and concrete products with new ones based on novel low CO₂ binders. This project was executed between January 2015 and December 2018 under the IA funding scheme.

The project's report on Standardisation Activities [15] aligns with existing harmonized standards for the cement compounds, which has no existing applicable standards or testing procedures. Consequently, the document details the complex procedure for applying to the technical committee CEN/TC 51 to establish a new European standard.

2.15.1 STANDARDS

The standardisation activities performed within the EcoBinder project were considered essential for the optimal dissemination of the new sustainable solutions and innovative products in the cement sector. There was a liaison with CEN/TC 51 (Technical Committee of

CEN in charge of standardisation for cements, limes, and other hydraulic binders) and cement producers (Heidelberg Cement, Lafarge, Holcim, and Vicat).

This document also displayed several standards for differentiation and testing (**Table 5**):

Table 5: Testing standards (ECO-Binder project)

Standard	Description
EN 197-1	Cements are differentiated from common cements according to this standard. This standard uses the assessment and verification of consistency of performance system.
EN 14647	Referenced as a standard for specialty cements that eco cements differ from.
EN 197 and EN 206	It is expected that the new cements and concretes formulas should be tested as much as possible according to these standards.

Due to the significant change of using eco cement (stability and characteristics), the manufacturer must check the existing harmonised European standard (EN 14992). Moreover, the application should be submitted to the Technical Committee CEN/TC 51 to decide the inclusion of the new items.

2.15.2 TECHNOLOGIES

The primary technological output of the project relates to low-carbon binders and the construction components created using them, and the development of insulating concrete systems and innovative facade panels. These panels aim to be a new family of eco-innovative, durable, and energy efficient components (reduced carbon footprint and improved thermal properties).

The reduction of the carbon footprint is possible thanks to the use of a new type of cement binder. This eco cement family is composed of a new type of clinker, causing it to differ substantially from existing standardized cement types.

2.15.3 POLICIES

The core policy output is the establishment of a pathway to ensure market viability and widespread use of new solutions. The primary regulatory framework governing construction products is the Construction Product Regulation, which lays down harmonised rules for marketing construction products in the EU. The solutions (eco cements and facade panels) should comply with the Construction Product Regulation.

A critical preliminary policy requirement for standardisation is that the patent holder must agree to allow the incorporation of the patented technology into new standards without financial compensation or at fair, reasonable and non-discriminatory conditions.

2.16 CISUFLO

CISUFLO sets up a systemic framework for circular and sustainable floor coverings (carpets, resilient floor coverings and laminates) and minimises the sector's total environmental impact. This project was executed between June 2021 and June 2025 under the IA funding scheme.

The deliverable "Overview of standards and certificates applicable to CFC (Circular Floor Covering) and strategy for further development" [16] provides a comprehensive overview of existing and developing standards pertinent to ensuring circularity in the flooring sector. The analysis highlights active standardisation efforts aimed at creating uniform terminology, establishing methodologies for end-of-life material identification, and defining procedures for the quality assessment of secondary raw materials.

2.16.1 STANDARDS

The standardisation topics covered in this report include uniform terminology, design for recycling, guidelines to facilitate end-of-life treatment, end-of-life material identification, and secondary raw material quality assessment. The standardisation strategy for the future recommends that floor coverings should fit into one of the existing certification schemes, based on a clear understanding of the terms and definitions specific to floor coverings.

CISUFLO also works with technical committees aiming for the delivery of relevant standards for specific products and categories. CEN TC134 (textile, laminate, and modular multilayer floorcoverings) and CEN TC249 (plastics) are involved in the development and execution of this standardisation request.

The high volume of existing certificates and labels globally makes standardisation critical for clarity. Certification schemes utilize various standards to verify claims. Standardisation should act as a universal translator and ruler for the circular economy and make claims by manufacturers measured and understood consistently across different countries and industries.

2.16.2 TECHNOLOGIES

We could not obtain any relevant information or data linked to technologies during our consultation.

2.16.3 POLICIES

We could not obtain any relevant information or data linked to policies during our consultation.

2.17 CIRC-UIITS

CIRC-UIITS demonstrates the improvement to the circularity of the automotive and mass electronics sectors by reuse of semiconductors from different sources. It will also support the remanufacturing of semiconductors into new (high added value) components and

products in these sectors. This project was executed between January 2023 and December 2025 under the RIA funding scheme.

The report on “Standardisation activities” [17] pinpointed the need for criteria related to the digital product passport, standardised methods for CO₂ calculation, and metrics for product repairability and disassembly. The ultimate goal of this work was to define a clear standardisation strategy, ensuring the project's solutions are compliant with existing standards while preparing to transfer project results into ongoing activities or the initiation of new standardisation documents.

2.17.1 STANDARDS

The CIRC-UITs project recognizes the importance of standardisation for developing compliant and trustworthy solutions, conducting extensive research to map the standardisation landscape. The research identified several key TCs working on standards relevant to CIRC-UITs at the international levels (**Table 6**):

Table 6: Key TCs working on standards identified by CIRC-UITs project

TC Number	TC Title
ISO/TC 22	Road vehicles
ISO/TC 207	Environmental management
ISO/TC 298	Rare earth
IEC/TC 47	Semiconductor devices
IEC/TC 91	Electronics assembly technology
IEC/TC 111	Environmental standardisation for electrical and electronic products and systems
IEC/TC 119	Printed electronics

The project seeks to transfer its results into standardisation by contributing to ongoing activities or initiating new ones based on identified gaps. The following five standardisation potentials were identified during a workshop to determine where standardisation is still needed:

1. Activities related to digital product passport.
2. A common way to store all information about repairability of a product in a data format.
3. CO₂ calculation for materials, products and technologies (to ensure there is no green washing).
4. Additional KPI's for sustainability (which must be defined and decided how to calculate them).
5. Repairability and a possibility to disassemble parts.

2.17.2 TECHNOLOGIES

We could not obtain any relevant information or data linked to technologies during our consultation.

2.17.3 POLICIES

Project results must be compliant with the legislation framework. For instance, the REACH Regulation (EC) 1907/2006 covers the components used for critical materials and international material data system in the automotive industry.

The project also identified the need for plans to define additional KPIs for sustainability (and how to calculate them). A key gap found is the need for policies regarding CO2 calculation for materials, products and technologies to prevent greenwashing. The project focused on defining policies and requirements for repairability and a possibility to disassemble parts.

3 ONGOING PROJECTS

Several ongoing IS or CE projects with potential standardisation activities were identified during this task. To verify their relevance, coordinators of 26 projects were contacted. From these, four projects provided useful data based on direct input from their coordinators, as no public deliverables on IS standardisation were available at the time of this report. For the remaining projects, either no response was received or coordinators confirmed that no standardisation work is planned. Projects without a response will still be considered in Task 4.2 if they produce relevant outcomes in the future.

3.1 ICARUS

ICARUS [18] demonstrates new technologies to upgrade Secondary Raw Materials from Waste (SRMs) ensuring similar quality to primary raw materials for three targeted waste streams (lithium aluminosilicate, waste cellulose and steel slags), to improve CE principles with its implementation in the construction sector. One of the expected project results focuses on training skills development and standardisation approaches to support wider adoption of secondary raw materials to facilitate their integration in the market and reduce the carbon footprint in the construction industry. This project is executed between January 2024 and December 2027 under the RIA funding scheme.

In this task, an initial study of the standardisation landscape will be performed, targeting the compliance of the project developments and products with relevant existing standards. In parallel, the task will identify standardisation needs aiming to facilitate future market uptake of the secondary materials produced by the project. A report will be produced on standardisation needs and recommendations to relevant bodies.

The objective is to identify existing legislation, guidelines and standards affected by the project's research results. This action line involves 3 stages:

- Stage 1: Draw up a technical characterisation of the SRM resulting from the reuse/recycling of waste proposed by the project.
- Stage 2: Identify which products are to be replaced by the materials resulting from the reuse of waste and consider their standardisation as a benchmark. Assess the need for specific standardisation for the new products/materials.
- Stage 3: Write a report containing the results of the characterisation and assessment of the products/materials, with indications and recommendations on the need for standardisation and other issues inherent and relevant to the task's objectives.

3.2 SYSCHEMIQ

The SYSCHEMIQ [19] project aims to support CE transition by providing stakeholders with a demonstration of methodologies focused on plastic recycling and reducing waste generation. To achieve this, SYSCHEMIQ will enable a demonstration of these methodologies within an industrial, cross-border district between the Netherlands, Belgium and Germany. This project will be executed between September 2022 and August 2026 under the IA funding scheme.

In the systemic demo, both governance and technological innovations as well as value chain alignments will be tested and demonstrated on the case of mixed plastic waste recycling. In different use cases, SYSCHEMIQ will analyse and characterise plastic and bio-waste streams in the trilateral region and define Recycling Quality Standards that can be realised when aligning the value chain partners.

The project also develops a sustainable transition pathway, including scenarios for the integrating advanced sorting technologies, large-scale chemical recycling as well as biogenic feedstock to neutralise carbon leakage in the plastics recycling chain. Several systemic innovations will be tested on real-life cases of transition management.

3.3 REBUILT

ReBuilt [20] focuses on advancing CE in the construction sector through the development of digital solutions, including DPPs, that support the sustainable use and traceability of materials. The project will also develop an educational programme for circular construction practitioners, as well as procedures for achieving end-of-waste status for recovered materials. This project will be executed between January 2023 and December 2026 under the Interreg funding scheme.

A key element is the integration of these solutions with existing EU policies and regulations, along with the creation of coherent data-exchange rules across the construction value chain. Standardisation and alignment with European frameworks are central to the project, enabling the practical implementation of DPPs and other digital tools that support circular construction practices.

Relevant policies and regulations include the use of Gaia-X specifications (which provide a standard implementation of the specifications through software components) and EN 15804, which sets the core rules for developing Environmental Product Declarations for construction products and services.

On the technological side, the project already applies DPPs for managing products' digital footprints, implements systems for material tagging and cataloguing, integrates model generation and exchange, and offers a web portal that consolidates these functionalities in a unified environment. The system is expected to be fully launched in 2026.

3.4 SYMSITES

SYMSITES implements regional industrial urban symbiosis in four European regions that differ from one another in social economic, and environment aspects (north Denmark, mid Austria, south Spain and Greece). The four Ecosites use the same technologies for wastewater, waste treatment and energy production between urban and industrial entities. This project was initiated in 2022 and will be executed until May 2026 under the RIA funding scheme.

The deliverable “A dossier with the relevant policies and standards” [21] highlights IS as a critical pathway for sustainability and the circular economy within European cities. The core theme revolves around overcoming non-technological barriers (such as regulatory, financial,

and social constraints) that impede the scaling of IS systems, including wastewater reuse and waste valorisation.

3.4.1 STANDARDS

A broad selection of standards was identified for potential relevance to IS. A concise list was analysed focusing on the development of a first defining IS standard, aligned with standardisation efforts in the circular economy and sustainable urban development.

The starting point was the CEN workshop agreement and the Circular Economy Standards (ISO 59000 Series). These references provided guidance for transitioning from linear to circular models and outlined requirements for evaluating and measuring circularity performance using mandatory and optional indicators.

Considering the CEN Workshop Agreement, the proposed standardisation effort tries to account for new stakeholders (local government), new resources (urban wastewater, organic waste), and new performance metrics (circularity indicators), ensuring the design is not just for industry but for the entire symbiotic urban-industrial community.

The Spanish Ecosite action plan aims to define a standard for symbiotic exchange (treatment and valorisation of waste streams) to manage stakeholder roles, pricing, and dispute resolution for efficient exchanges. The Austrian EcoSite proposes to collaborate with the Austrian Water and Waste Management Association to create a new technical data sheet on water quality for wastewater reuse, aiming to implement the minimum quality requirements.

3.4.2 TECHNOLOGIES

Several existing and proposed technologies are used or recommended in this project for IS implementation, particularly in waste valorisation and water management as demonstrated in **Table 7**:

Table 7: Proposed technologies for IS implementation in SYMSITES project

Technology	Description
Anaerobic Membrane Bioreactor	Used at the Spanish Ecosite to treat industrial and urban wastewater along with organic solid waste.
Magnetic Membrane Vibration	An innovative technology at the Spanish Ecosite to enhance membrane performance by reducing fouling and improving filtration efficiency.
Tertiary Treatment	Implemented at the Spanish Ecosite as part of the overall wastewater treatment strategy.
Anaerobic Digestion	A process used at the Austrian Ecosite pilot plant to produce energy in the form of biogas using organic kitchen waste from school canteens and industrial wastewater.

Ultrafiltration	Used in the Austrian Ecosite to treat wastewater for reuse in irrigating municipal green spaces or for street cleaning.
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3.4.3 POLICIES

SYMSITES is strongly linked with the Regulation on Water Reuse (EU 2020/741). This regulation sets minimum requirements for water reuse and is central to the Danish and Austrian Ecosite strategies. The collaboration with the Austrian Water and Waste Management Association helps to create a new "technical data sheet" on water quality for wastewater reuse.

In the Spanish Ecosite, the regulatory actions include:

- Identifying bottlenecks related to waste regulations.
- Developing a compliance roadmap for waste regulations.
- Conducting workshops with regulatory bodies to align on waste regulations.

The report also mentions negotiations with the Austrian Federal Ministry to improve the legal framework for biogas projects, including potentially implementing a "renewable gas act".

4 CONCLUSIONS

This mapping exercise confirms that **standardisation is a critical enabler for accelerating the transition to a functional and widespread CE**. The complexity of IS—with its cross-sectoral nature—creates significant challenges that standards can help overcome.

The analysis of 21 projects demonstrates that **standards are not merely technical specifications**; they are strategic tools for:

- **Building trust and transparency** among IS partners.
- **Ensuring legal compliance and interoperability** across sectors.
- **Facilitating the integration of innovative technologies and practices** into existing frameworks.

Key insights from this deliverable include:

- **Urgent need for harmonisation** of LCA methodologies and data documentation standards to enable consistent cross-sector collaboration.
- **Digital transformation technologies** (AI, IoT, cloud platforms) require new standards for data sharing, interoperability, and DPPs.
- **Adaptation of existing standards** or creation of new ones for sustainable products derived from waste streams (e.g., low-carbon cement, bio-based polymers).
- **Clear definitions and uniform criteria** for End-of-Waste (EoW) and By-product status to support resource reuse and valorisation.

European policies such as the **Green Deal** and **Circular Economy Action Plan** remain strong drivers for standardisation. However, gaps persist in policy implementation, particularly in:

- Reducing administrative barriers and ensuring coherence across regulations.
- Integrating regulatory analysis early in technology development.
- Introducing financial incentives and support mechanisms to accelerate market uptake of circular solutions.

In summary: Standardisation is essential for scaling IS practices, fostering innovation, and achieving Europe's sustainability goals. The findings of this deliverable provide a solid foundation for defining future research priorities and shaping policy frameworks that enable a truly circular economy.

5 NEXT STEPS

The mapping exercise presented in this deliverable provides a solid foundation for advancing IS standardisation. Building on these insights, the next phase (Task 4.2 – Identify research and innovation priorities for IS standardisation) will focus on transforming findings into strategic priorities and actionable recommendations.

Immediate Priorities

- **Cross-Analysis:** Compare the outcomes of the 21 identified projects with the priority synergies defined in WP3 to uncover gaps and opportunities.
- **Gap Identification:** Highlight areas where standardisation is lacking or insufficient, particularly in cross-sector collaboration, digital tools, and sustainable product standards.
- **Integration of New Data:** Reassess projects not included in this deliverable and incorporate emerging results from ongoing initiatives.

Strategic Actions

- **Develop a Prioritised List of Standardisation Needs:** Create a clear roadmap of critical gaps to guide future research and innovation efforts.
- **Formulate Recommendations for R&I Funding Calls:** Ensure upcoming calls encourage demand-driven innovation and address systemic bottlenecks in IS standardisation.
- **Engage with Key Stakeholders:** Strengthen collaboration with standardisation bodies, policymakers, and industry leaders to accelerate adoption and harmonisation.

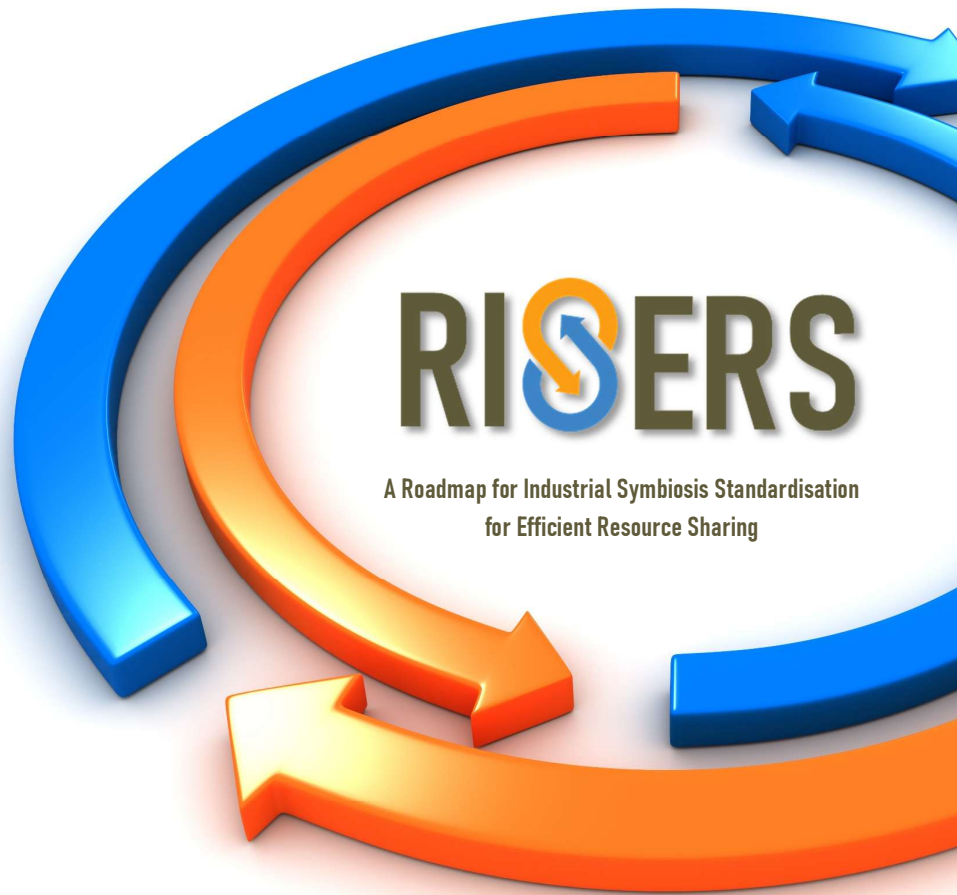
Expected Outcomes

- A comprehensive set of **strategic priorities** for IS standardisation.
- Concrete **recommendations for funding programs** aligned with market and policy needs.
- Enhanced **stakeholder engagement** to ensure practical implementation and scalability.

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D4.1 ANNEX 1

SUMMARISED TABLE OF D4.1 IS PROJECTS

DUE DATE: 31.12.2025

RESPONSIBLE PARTNER: ISQ



Funded by
the European Union

INTRODUCTION

This document serves as an Annex 1 to the RISERS project Deliverable 4.1 'Map of current R&I Activities related to the Priorities for Industrial Symbiosis Standardisation', providing a summarised table of the 21 IS projects described in T4.1 "Map current R&I projects supporting IS standardization".

The following table gives a concise overview of the 21 projects identified in D4.1. which contributed to IS standardisation. All the projects are categorised by their full titles, implementation details, sectoral focus, and key outputs regarding standards and policy recommendations.

SUMMARISED TABLE OF D4.1 IS PROJECTS

Table 1 details the 21 IS projects present in D4.1 and respective key elements concerning standardisation.

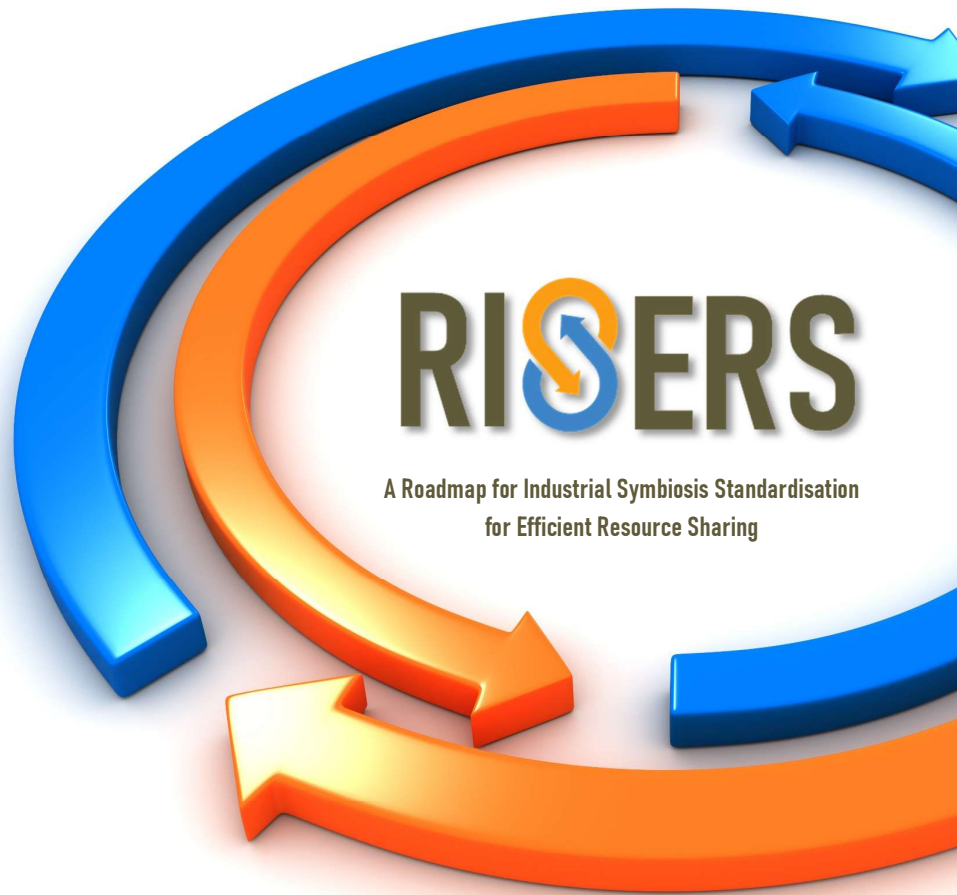
Table 1: Summarised table of D4.1 IS projects

Project	Title	Duration	Funding	Sectors	Standardisation Inputs	Policy Recommendations
<u>SCALER</u>	Scaling European resources with industrial symbiosis	Nov 2017 – Oct 2020	CSA	Process Industry / IS	Analysed 286 national/international standards. Identified needs for digital transformation and smart manufacturing.	Used policy levers (European Green Deal and Circular Economy Action Plan) to set requirements for sustainable products.
<u>SYMBIOPTIMA</u>	Human-mimetic approach to the integrated monitoring, management and optimization of a symbiotic cluster of smart production units	Sept 2015 – Feb 2019	RIA	Production Plants / Energy Data	Proposed waste flow characterization and a European Waste Catalogue for secondary raw materials.	Leveraged the Eco-design Working Plan to drive standardisation for product durability and safety.
<u>REHAP</u>	Systemic approach to Reduce Energy demand and CO2 emissions of processes that transform agroforestry waste into High Added value Products	Oct 2016 – Mar 2021	IA	Construction / Agroforestry Residues	Developed standards for bio-based products, including bio-based content declaration, sustainability criteria, and LCA application.	No specific policy recommendations identified in this report.
<u>HARMONI</u>	Harmonised assessment of regulatory bottlenecks and standardisation needs for the process industry	Aug 2017 – Oct 2019	CSA	Process Industry / IS	Integrated new research into existing frameworks. Identified needs for data sharing standards and addressing IS complexity/variability.	Harmonised European waste, water, and energy policies. Involved regional policy makers in regulation development.

<u>REMADYL</u>	Removal of Legacy Substances from polyvinylchloride (PVC) via a continuous and sustainable extrusion process	June 2019 – Nov 2023	RIA	Plastics (PVC recycling)	Proposed EU-wide definitions for recycling yield and recycled content. Developed standards for substituting hazardous substances.	Supported market uptake of recyclates through tax reductions. Established EU-wide standards for analysing waste for classified substances.
<u>SHAREBOX</u>	Secure Management Platform for Shared Process Resources	Sept 2015 – Aug 2019	RIA	Energy Data	Developed the CEN Workshop Agreement (CWA) for IS to provide consensus on terminologies and core IS elements.	Used the CWA as a basis for widespread IS implementation. Aligned with the Waste Framework Directive to promote resource efficiency.
<u>CIRCPACK</u>	Towards circular economy in the plastic packaging value chain	May 2017 – Jun 2020	IA	Plastics/Packaging	Referenced standards for material characterization, compostability and CE metrics.	No specific policy recommendations identified in this report.
<u>RETROFEED</u>	Implementation of a smart Retrofitting framework in the process industry towards its operation with variable, biobased and circular Feedstock	Nov 2019 – Oct 2023	IA	Aluminium, Cement, Ceramic, Fertilizers, Steel	Collected sector-specific standards (e.g., ISO 45001, EN 197-1) to support process optimisation and equipment retrofitting.	Reduced administrative barriers. Included stakeholders in consultation processes. Implemented the "Innovation Principle" for investment.
<u>FISSAC</u>	Fostering industrial symbiosis for a sustainable resource intensive industry across the extended construction value chain	Sep 2015 – Feb 2020	IA	Construction (Ceramic, Cement, Metals, Chemicals)	Proposed standardisation for binary and sulpho-aluminate cements. Assessed new sub-products against aggregate standards (EN 12620).	Aligned standardisation with the Construction Products Regulation (CPR) and the Circular Economy Package.
<u>MEASURE</u>	Metrics for Sustainability Assessment in European Process Industries	Jan 2015 – Mar 2016	CSA	Chemistry, Steel, Automotive, Water, Waste	Recommended documentation standards for LCA data to prevent double counting. Harmonised performance indicators for emerging technologies.	No specific policy recommendations identified in this report.

<u>CORALIS</u>	Creation Of new value chain Relations through novel Approaches facilitating Long-term Industrial Symbiosis	Oct 2020 – Mar 2025	IA	Industrial Parks / IS	Expanded energy efficiency standards (ISO 50001) for inter-plant exchanges. Proposed standards for Digital Product Passports.	Establish detailed criteria for By-product and End-of-Waste status. Promoted Renewable Energy Communities.
<u>LIGHTME</u>	Lightweight metal alloys: shortening their path to commercial availability	Jan 2019 – Jun 2023	IA	Lightweight Metal Alloys	Linked with ISO TC 261 (additive manufacturing). Identified need for standards in inspection testing for aeronautics and automotive sectors.	No specific policy recommendations identified in this report.
<u>STAN4SWAP</u>	Standardising swappable battery systems for L-category vehicles	Dec 2023 – Nov 2025	CSA	Mobility / Batteries	Focused on standards for interoperability and compatibility of swappable battery systems and stations.	Contributed to the EU Battery Regulation (2023/1542) and Alternative Fuels Infrastructure Regulation.
<u>BIOMAC</u>	European Sustainable Biobased Nanomaterials Community	Jan 2021 – Jun 2025	IA	Biobased products (Automotive, Food Packaging)	Created a roadmap for nanomaterial characterisation, occupational exposure determination, and toxicological screening.	No specific policy recommendations identified in this report.
<u>ECO-BINDER</u>	Development of insulating concrete systems based on novel low CO2 binders for a new family of eco-innovative, durable and standardized energy efficient envelope components	Jan 2015 – Dec 2018	IA	Construction / Cement	Connected with CEN/TC 51 to establish new standards for low CO2 hydraulic binders and eco-concrete formulas.	Ensured compliance with the Construction Product Regulation. Addressed IP issues to allow patented technology in standards.
<u>CISUFLO</u>	Circular Sustainable Floor coverings	June 2021 – Jun 2025	IA	Flooring	Developed methodologies for end-of-life material identification and secondary raw material quality assessment.	No specific policy recommendations identified in this report.

<u>CIRC-UIITS</u>	Circular Integration of independent Reverse supply Chains for the smart Reuse of Industrially relevant Semiconductors	Jan 2023 – Dec 2025	RIA	Automotive / Electronics	Mapped standards for reparability metrics, disassembly, and standardised methods for CO2 calculation.	Defined policies to prevent greenwashing in CO2 calculation. Ensured compliance with the REACH Regulation.
<u>ICARUS</u>	Increasing circularity in process industries by upcycling secondary resources	Jan 2024 – Dec 2027	RIA	Construction	Identifies standardisation needs for Secondary Raw Materials to facilitate their market uptake and wider adoption.	No specific policy recommendations identified in this project.
<u>SYSCHEMIQ</u>	Demonstrator of systemic solutions for the territorial deployment of the circular economy in the Trilateral Chemical Region with a focus on plastic waste streams Quality for Recycling	Sep 2022 – Aug 2026	IA	Plastics	Define Recycling Quality Standards for mixed plastic waste recycling within cross-border value chains.	No specific policy recommendations identified in this project.
<u>REBUILT</u>	Circular and digital renewal of central Europe construction and building sector	Jan 2023 – Dec 2026	Interreg	Construction	Focus on procedures for End-of-Waste status and standardisation of DPPs. Promotes data-exchange rules across the value chain.	No specific policy recommendations identified in this project.
<u>SYMSITES</u>	Industrial Urban symbiosis and its social, economic and environmental impact on different European regions	2022 – May 2026	RIA	Urban / Industrial Symbiosis	Defines IS standards for wastewater reuse and organic waste. Collaborates on technical data sheets for water quality.	Aligns with the Regulation on Water Reuse (EU 2020/741). Identifies and removes bottlenecks in waste regulations.



D4.1 ANNEX 2

LIST OF CONTACTED ONGOING IS PROJECTS

DUE DATE: 31.12.2025

RESPONSIBLE PARTNER: ISQ



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INTRODUCTION

This document serves as an Annex 2 to the RISERS project Deliverable 4.1 'Map of current R&I Activities related to the Priorities for Industrial Symbiosis Standardisation', providing a list of the Ongoing IS projects contacted as specified in T4.1 "Map current R&I projects supporting IS standardization".

To create an overview of current IS Standardisation projects, several coordinators were identified and contacted to check any promising outcomes regarding IS standardisation in their projects. The early stage of these projects and the lack of public deliverables/reports provided limited data for this deliverable. The following list gives some interesting details concerning the present research panorama involving IS practices and activities.

LIST OF CONTACTED ONGOING IS PROJECTS

Table 1 details the 26 Ongoing IS projects contacted with general details about these projects.

Table 1: List of Ongoing IS projects contacted

Project	Name	Summary	Duration	Coordination
REINFORCE	Standardised, Automated, Safe and Cost-Efficient Processing of End-of-Life Batteries for Second and Third Life Re-use and Recycling	Developing a circular value chain solution for battery management, including optimized collection, diagnostics, robotic disassembly, safe handling, digital traceability (Battery Passport), and integration of second- and third-life applications before recycling.	June 2023 - May 2027	INEGI
EURO-TITAN	Decarbonized Titanium Recovery from Aluminium and Titanium Production Residues	Extract titanium resources from waste streams generated during the production of alumina and titanium dioxide. Additionally, it will transform residues into innovative construction materials and develop a green hydrogen-sourced directly from titanium reduction process.	Jan 2024 - Dec 2027	Clausthal University of Technology
SYMCRAFT	Creative craft for industrial symbiosis in circular economies	Advance circularity in the agro-food, textile, and wood/furniture sectors by designing resource-efficient business ecosystems. Through symbiotic craft practices, the project fosters sustainable economies across Central Europe.	Jun 2024 - Nov 2026	t2i
IS2H4C	Sustainable Circular Economy Transition: From Industrial Symbiosis to Hubs for Circularity	Innovative solutions in Hubs for Circularity strategically located in industrial areas across Germany, the Netherlands, Spain and Türkiye. Integration of cutting-edge sustainable technologies for circular ecosystems.	Jan 2024 - Jan 2028	Twente University

FABRIX	Fostering local, beautiful, and sustainably designed regenerative textile and clothing ecosystems	Promotion of sustainable urban manufacturing for textile and clothing sector through an integrated approach that encompasses spatial design, industrial symbiosis, circular manufacturing, and value chain management.	Jan 2024 - Dec 2026	Delft University of Technology
tExtended	Knowledge Based Framework for Extended Textile Circulation	Industrial-urban symbiosis developing and demonstrating effective textile recovery, waste valorisation and recycling processes combined with digital tools, sensing systems and data-driven solutions to support sustainable circularity of textiles.	Dec 2022 - Nov 2026	VTT
TRUSTEX	Advancing Sustainable Textiles in the Circular Economy through Innovative EPR Schemes	Integrating eco-design principles and design for disassembly technologies, identifying system weaknesses, and suggesting targeted solutions to manage textile waste. Covering key EPR activities, such as collection, sorting, reuse and recycling.	Jan 2024 - Dec 2027	Luxembourg Institute of Science and Technology
BioFibreLoop	Circular biobased technical textiles with innovative bio-inspired non-toxic functionalisation	Development of a new generation of renewable, recyclable, bio-inspired materials made of lignin, cellulosic and polylactic acid.	Jun 2024 - Nov 2027	DITF
SYMBA	Securing local supply chains via the development of new Methods to assess the circularity and symbiosis of the Bio-based industrial ecosystem enhancing the EU competitiveness and resource independence	User-friendly and accessible AI database suggesting regional IS innovative processes to create zero-waste value chains, ensuring more local supply chains and better distribution of economic and social benefits.	Jan 2024 - Dec 2026	ENCO
LIAISE	Cooperation, development and cross-border transfer of industrial symbiosis	This is the interdisciplinary research network that brings researchers and innovators together to investigate IS. The project offers an inclusive, pan-European environment for individuals to grow their professional research network and boost their careers.	Oct 2023 - Oct 2027	CETEM

SYMBIO	Shaping symbiosis in bio-based industrial ecosystems based on circular by-design supply chains	SYMBIO provides European regional communities with tools and methodological approaches to build bio-based business models based on circularity by design and industrial symbiosis.	Jan 2024- Dec 2026	Lombardy Green Chemistry Association
SYSCHEMIQ	Demonstrator of systemic solutions for the territorial deployment of the circular economy in the Trilateral Chemical Region with a focus on plastic waste streams Quality for Recycling	The SYSCHEMIQ project aims to support this transition by providing stakeholders with a demonstration of methodologies that can assist in transitioning to a circular economy that focuses on plastic recycling and reduced waste. To achieve this, SYSCHEMIQ will enable a demonstration of these methodologies in the industrial, cross-border district between the Netherlands, Belgium and Germany.	Sep 2022 - Aug 2026	Brightlands
CirclesOfLife	Enhancing material circularity and Lower Emissions of Ship building processes in all phases of the LIFE cycle	Developing a methodology and framework to evaluate the environmental performance of European shipyards (from new building projects to recycling yards).	Jan 2024- Dec 2026	DAMEN Shipyards
HURRICANE	Sector-coupling hub for circular use of thermal and industrial waste	Developing and demonstrating novel heat recovery (heat exchanger) and upgrading (heat pumps) solutions from selected operations and then coupling it with the internal and external off takers by means of a heat grid.	Jan 2024 - Dec 2028	ARCELORMITTAL
ReBuilt	Circular and digital renewal of central Europe construction and building sector	The project will, among others, develop an educational program for circular construction practitioners in this industry, as well as develop the end-of waste status procedures.	Jan 2023 - Dec 2026	Slovenian National Building and Civil Engineering Institute
REPLAN CITY LIFE	Relevant Audience Plan Leading to Awareness Network for Circular Economy Use of Recycled Tire materials in CITY LIFE	The project is aimed at raising awareness about the CE/IS opportunities for materials obtained from tyre recycling in: concrete and building (steel fibres reinforced concrete for industrial flooring and roads, rubber sheets and layers for <u>noise reduction, recycled fibres textile panels for</u>	Jan 2022- Dec 2027	ETRA

		insulation), urban and street furniture, sports and leisure products.		
MoeBios	Improving waste management of biobased plastics and the upcycling in packaging, textile and agriculture sectors	Improving the recycling technologies for biodegradable bioplastics deriving from textiles, agriculture and packaging applications. MoeBIOS focuses also on the collection and sorting of the bioplastic waste (simulated streams) and offers solutions for the upcycling and validation of the final recycled end-products.	June 2024-May 2028	ITENE
ReBioCycle	A new European blueprint for circular bioplastics upcycling solutions	Provides a portfolio of bioplastic sorting and recycling technologies within three complementary waste-processor-centric hubs at a demonstration scale and in the real operational environment the effective and efficient recycling of three types of bioplastics (e.g., PLA, PHA, composites) to demonstrate a higher impact of obtaining the same or superior grade recycled polymers and other higher-value applications.	Oct 2024-Sept 2028	University College Dublin
InSoil	Safe bio-based and biodegradable IN-SOIL solutions for circular and sustainable crop production	INSOIL tackles agricultural plastic pollution by developing three families of fully bio-based, safe in-soil biodegradable products in the form of mulch films, plant guards and controlled-release fertilisers (CRFs), to replace widespread single-use plastics in crop production.	June 2025-May 2029	ITENE
BeUp	Boosting the industrial uptake of biodegradable polymers for packaging applications by implementing digital tools and advanced techniques to achieve a holistic sustainability goal	Develop and demonstrate novel biodegradable and recyclable formulations for sustainable packaging materials to replace conventional ones like PE, PP and PET while improving sustainability, and reducing up to 40% of GHG emissions, using efficient processes and guaranteeing their safety and security, to finally create an effective circular business model.	May 2025-April 2029	ITENE

Greco	Innovative bio-based Biodegradable Recyclable safe and Circular Food packaging	Demonstrate the life cycle and economic feasibility of safer bioplastic value chains for food packaging using a safe and sustainable by design strategy. It will develop new biodegradable and recyclable packaging with PLA copolymers, coatings, additives, and surface treatments.	May 2025– April 2029	Aristotle University of Thessaloniki
Bio4Coat	Biobased building blocks from biorefinery for safe diamond-like and bio polyurethane coating solutions under extreme and demanding conditions of use and end of life	BIO4COAT aims to validate at TRL 5 the use of 3 biobased building blocks (1,4-bioBDO, LcDCA, and biomethane) from Novamont's biorefinery for producing safe and sustainable biobased coating solutions.	June 2025– May 2029	Fundacion Tecnologica Advantx
AshCycle	Integration of Underutilized Ashes into Material Cycles by Industry-Urban Symbiosis	Investigate new methods for recovering useful elements contained in the ashes of raw materials to be processed for industrial use. Pilot demonstration projects will be carried out in Belgium, Croatia, Denmark, Finland, the Netherlands, Slovenia, Switzerland and South Africa.	June 2022 – May 2026	University of Oulu
WaterProof	Urban WASTE and water Treatment Emission Reduction by utilizing CO2 for the PROduction Of Formate derived chemicals	Innovative electrochemical process that converts CO2, originating from waste incineration and wastewater processing, to produce green consumer products (e.g formic acid).	June 2022 – May 2026	Avantium
Theseus	A First of a kind Hub for circularity demonstrator for Attica and peripheral regions	Establish the first Hubs4Circularity in Greece to close resource loops with innovative urban solutions and develop water, energy and material technologies based on regional needs, incorporating digital and robotic solutions.	Dec 2024 – Nov 2029	ICCS
United Circles	Networked industrial-urban symbiosis value chain demonstrators for biomaterials, C&DW, circular water loops & WWTPs, driven by Hubs 4 Circularity	Demonstration with 46 partners across 14 countries + 1 international body, three Industrial-Urban Symbiosis value chains, to upcycle of urban Food Waste, urban Wastewater Solids, and urban Construction & Demolition Waste (C&DW).	Nov 2024 – Oct 2028	CARTIF