A Practical Nine-Step Guide to
R&I Design for Industrial Symbiosis Standardisation

Making Research and Innovation Fit for

Industrial Symbiosis Standardisation



RISERS A Roadmap for Industrial Symbiosis Standardisation for Efficient Resource Sharing

This Guide constitutes RISERS' Deliverable 4.2 „Awareness/Training Materials Targeting Standardisation Activities for R&I Project"

This deliverable remains subject to the European Commission review and approval.



A Roadmap for Industrial Symbiosis Standardisation for Efficient Resource Sharing

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About this guide

About this guide

This guide was developed within the RISERS project - A Roadmap for Industrial Symbiosis Standardisation for Efficient Resource Sharing. RISERS analysed Industrial Symbiosis standardisation gaps, relevant R&I activities and areas where additional knowledge and evidence are needed. The guide translates these findings into a practical implementation-oriented tool for designing R&I activities that can help address those gaps and support the Industrial Symbiosis Standardisation Roadmap.

Scope and limitations

This guide does not explain how standards are developed, how to participate in formal standardisation processes, or how to manage engagement with standardisation bodies. Existing CEN-CENELEC, European Commission, Standards+Innovation and Horizon Standardisation Booster resources already cover these topics. This guide complements them by focusing on how R&I itself should be designed to produce methods, data, criteria and evidence that may later support standardisation. See "Useful resources" at the end of the brochure.

Who is this guide for?



R&I Project coordinators and exploitation/impact leads

To integrate standardisation considerations into project design, implementation, exploitation and impact planning, and to ensure that relevant outputs, evidence and follow-up pathways are addressed throughout the project



Researchers

To design and carry out research, testing, validation and evidence-generation activities that can produce robust and transferable outputs relevant to standardisation.



Industrial and technology partners

To provide practical requirements, industrial application cases, operating conditions, data and validation input, and to assess whether proposed outputs are usable in real industrial symbiosis settings.



Standardisation and technical experts

To better understand how R&I projects can develop outputs and evidence relevant to standardisation, how R&I can support standardisation needs, and how standardisation can be integrated into project design and implementation, including the identification of appropriate standardisation pathways.



R&I funding organisations

To identify where pre-normative R&I, testing, validation or other evidence-generation activities are needed to address industrial symbiosis standardisation priorities and to inform the design of relevant funding topics and calls.



R&I support organisations, research managers and training providers

To raise awareness and build capacity among researchers and project coordinators regarding the integration of standardisation into R&I activities.

What is Industrial Symbiosis?

Industrial Symbiosis (IS) is the use by one company or sector of underutilised resources - including waste, by-products, residues, energy, water, logistics, capacity, expertise, equipment and materials - from another, with the result of keeping resources in productive use for longer.

CEN Workshop Agreement 17354

Why R&I for IS standardisation?

Because IS connects organisations and sectors that may use different technical requirements, terminology, data systems, quality criteria and regulatory frameworks, scaling successful exchanges often requires common approaches that actors can understand, compare, test and apply across organisational boundaries. These gaps matter to industry, technology providers, researchers, public authorities and standardisation organisations because they can limit confidence, interoperability, replication and market uptake.

Standardisation can provide common rules and approaches, but it needs research to fill scientific and technical evidence gaps. R&I is required for standards revision or development, particularly for emerging technologies, cross-sector applications and areas where methods or evidence are not yet sufficiently mature to ensure interoperability.

Standardisation – a knowledge valorisation pathway

Standardisation is recognised as a pathway for exploiting and valorising R&I results. In the context of IS, this is particularly relevant where the Industrial Symbiosis Standardisation Roadmap identifies priority areas in which further evidence, testing or validation is still needed before standardisation can progress. If standardisation is a credible route for a project result, it should therefore be considered early enough to influence what is developed, tested, validated and documented. Simply mentioning standardisation in an exploitation plan is not enough—the project needs to generate a concrete, evidence-based and transferable contribution.

This approach is reflected in the Horizon Europe Programme Guide, the European Commission's Code of Practice on standardisation in the European Research Area, and its guidance on dissemination and exploitation of research results. The present guide translates this principle into practical guidance for R&I projects addressing IS standardisation needs identified in the Roadmap.

What R&I can provide for IS standardisation?

Harmonised methods and metrics	Develop and validate common terminology, KPIs, assessment methods, testing approaches and calculation rules.
Cross-sector interoperability	Develop common data structures, protocols, interfaces and information requirements so sectors and systems can work together.
Emerging solutions	Generate knowledge and methods for new materials, technologies and circular practices where established normative guidance is still missing
Pre-normative evidence	Test performance, safety, durability and wider applicability so standardisation bodies have a stronger evidence base for consensus and standards development or revision.

Consult the IS Standardisation Roadmap

What makes an R&I output potentially useful for IS standardisation?

Not every R&I result is automatically suitable for IS standardisation. A result becomes potentially useful when it has characteristics that allow it to support the development, revision or wider application of common approaches relevant to IS.

The guide therefore considers four basic features: whether the result addresses a genuine need, produces a sufficiently concrete output, is supported by appropriate evidence, and can be applied beyond the original project context.

Relevant

The result addresses an IS problem for which different actors need a sufficiently common approach. It should respond to a need that extends beyond one project, company or individual use case

Concrete output

The project produces something that can be shared, applied or further developed, such as terminology, a classification, dataset, method, test approach, performance criteria, data requirements or an assessment methodology.

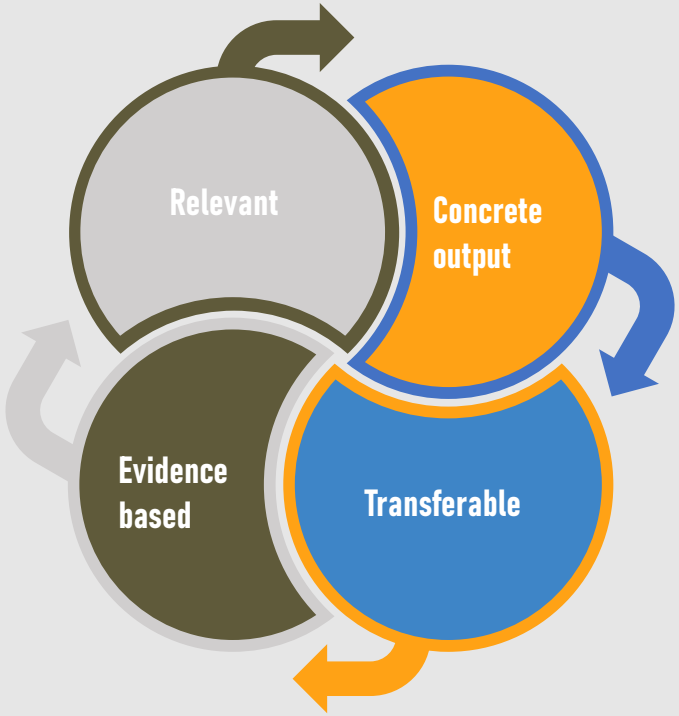
Evidence based

The result is supported by evidence appropriate to the type of contribution. This may include testing, comparison with existing approaches, validation across relevant cases, stakeholder assessment or other evidence showing that the approach is reliable for its intended use.

Transferable

The result should be supported by evidence showing that it is applicable beyond the specific project cases and can underpin a common approach. Its wider applicability, as well as any limitations, boundary conditions and context-specific elements, should be understood and, where appropriate, demonstrated across relevant users, sites, sectors, systems or regulatory contexts.

Key features of an R&I output with standardisation potential



A useful contribution to IS standardisation is therefore not defined only by what the project develops, but also by the need it addresses, the evidence supporting it and its potential for wider application

Guide Structure

The guide is organised as a nine-step process for designing R&I activities that can generate outputs and supporting evidence relevant to IS standardisation.

The process starts with identifying the relevant R&I need and understanding how it relates to other horizontal, sector-specific and system-level needs. It then helps the project define the potential standardisation-related challenge, review the existing standardisation landscape and specify what the R&I activity should provide.

The following steps focus on engaging the relevant actors, planning the evidence needed and building and demonstrating transferability. The final step considers how the R&I output can be taken forward through the most appropriate standardisation-related pathway.

The steps are intended as a practical design framework rather than a rigid procedure. Depending on the project, some steps may need to be revisited iteratively as new evidence is generated, stakeholder input is received, or the standardisation landscape evolves.



The standardisation-related valorisation of an R&I output does not necessarily have to lead directly to the development of a new standard. Depending on the maturity of the output, the supporting evidence and the existing standardisation landscape, the most appropriate route may involve further pre-normative R&I, development of guidance or a reference methodology, contribution to ongoing standardisation work, revision or modification of an existing standard, development of a CEN/CENELEC Workshop Agreement (CWA), or initiation of new standardisation work. This overall approach is consistent with CEN-CENELEC Guide 23:2020, which recognises different ways in which R&I projects can contribute to ongoing and future standardisation work.

Identify the relevant R&I need(s)

Start by defining the R&I need the project intends to address and determine whether it is primarily sector-specific, horizontal or system-level.

Identify the primary R&I need, while noting any related needs at the other levels that may influence the solution. These interdependencies are considered in Step 2.

The following RISERS outputs provide a structured starting point for identifying relevant R&I needs:

- Map of Current R&I Activities Related to the Priorities for Industrial Symbiosis Standardisation
- Map of Standardisation-Related R&I Needs
- Industrial Symbiosis Standardisation Roadmap

Sector-specific needs

Linked to a particular material, technology, resource stream or application

Typical R&I needs examples:

- material-specific characterisation
- application-specific test methods
- performance, quality or safety evidence
- validation under relevant industrial conditions

Horizontal needs

Relevant across sectors or IS applications

Typical R&I needs examples:

- terminology and definitions
- resource classification and descriptors
- data structures and interoperability
- measurement and assessment approaches
- common KPIs, quality criteria or verification approaches

System level needs

Wider enabling and upscaling conditions for IS

Typical R&I needs examples:

- infrastructure & spatial planning
- governance & contracting
- information sharing
- skills and competences
- financing & investment conditions
- organisational, institutional, regulatory barriers & enablers

1.

Consult Map of Current R&I Activities Related to the Priorities for Industrial Symbiosis Standardisation

Consult Map of Standardisation-Related R&I Needs

Priority R&I needs for IS standardisation

The following tables summarise the identified challenge or gap, the type of R&I that may be needed, and illustrative examples of possible R&I outputs.

Sector-specific needs

Area	R&I need / challenge	Illustrative R&I output
Steel, slag and refractories	Improve characterisation and quality assessment of secondary metallurgical materials, account for variability and generate evidence for safe use in receiving applications.	• chemical/mineralogical characterisation; • sampling/test protocols; • durability criteria; • environmental-safety assessment; • performance requirements.
Batteries	Develop reliable approaches for assessing second-life suitability, State of Health / Remaining Useful Life, traceability and safe cross-sector use.	• SoH/RUL assessment; minimum datasets; • performance protocols; • traceability/data requirements; • safety evidence.
Packaging	Improve assessment of recyclate quality, recyclability, contamination and the use of secondary or alternative feedstocks.	• recycling-quality methodology; • design-for-recycling criteria; • test methods; recyclate-quality specifications; • traceability requirements.
Waste heat	Improve comparability of waste-heat data and the evidence base for industrial heat recovery and high-temperature applications.	• common descriptors and measurement boundaries; • heat-data structures; • test/assessment methods; • performance and durability methods.
Textiles	Improve sorting, grading, recycled-content assessment, recycled-fibre quality and performance assessment.	• grading system; • fibre-identification and recycled-content methods; • quality specifications; • durability/functionality tests.
Biomass and waste wood	Improve characterisation of bio-based feedstocks and methods for assessing content, quality, variability and suitability for industrial applications.	• biomass-content methodology; • feedstock quality criteria; • sustainability-data requirements; • methods addressing variability.

Horizontal needs

Area	R&I need / challenge	Illustrative R&I output
Terminology and concepts	Terms and classifications are used inconsistently, limiting comparison and transfer. R&I should compare existing approaches, clarify concepts and validate definitions across relevant users and sectors.	• validated terminology; • common resource descriptors; • classification framework.
Resource status and End-of-Waste	Different criteria and interpretations create uncertainty for secondary resources. R&I should generate evidence for classification, quality, traceability and application-specific criteria.	• characterisation methodology; • quality criteria; • traceability approach; • evidence supporting End-of-Waste criteria.
Data and interoperability	Resource and process data may use incompatible formats, semantics, identifiers or interfaces. R&I should develop and validate common data fields, metadata structures and interoperability approaches.	• minimum dataset; • common data structure; • metadata model; • interoperability specification.
Measurement, indicators and sustainability assessment	Results may not be comparable when projects use different KPIs, boundaries or calculation rules. R&I should develop transparent indicators, boundaries and calculation rules and validate them across use cases.	• KPI framework; • reference calculation method; • assessment methodology; • data-documentation approach.
Quality, characterisation and verification	Wider use of secondary resources requires reliable evidence on composition, performance, quality, safety and variability. R&I should develop and validate sampling, characterisation, testing, grading and verification approaches.	• sampling protocol; • characterisation/test method; • grading scheme; • quality or acceptance criteria.

System level needs

Area	R&I need / challenge	Illustrative R&I output
Energy data and grids	Different metering, monitoring and control systems can limit coordination across organisations. R&I may be needed to improve compatibility of formats, units, metadata and communication approaches.	• energy-data structures; • interoperability protocols; • common descriptors; methods for secure cross-organisational data exchange.
Digital Product Passports and traceability	Digital tools need usable identifiers, datasets and rules enabling information transfer across actors and sectors.	• minimum datasets; identifiers; data-quality rules; • material traceability requirements; • links between physical assets and digital records.
Knowledge, skills and capacity	Implementation may require competences in characterisation, testing, digital systems, assessment and cross-sector collaboration.	• competence frameworks; • training requirements; • methods for assessing skills needs; • common training content.
Governance, contracting and information sharing	Companies need workable approaches to data access, confidentiality, liability, responsibilities and long-term cooperation	• governance frameworks; • contractual models; • common information requirements; • risk-allocation approaches.
Infrastructure and spatial planning	IS may depend on shared physical infrastructure and spatial relationships between resource providers and users.	• planning methodologies; infrastructure-assessment approaches; common criteria for technical and spatial feasibility.
Economic and financial enablers	Investment may be constrained by uncertainty about costs, benefits, responsibilities and financing of shared infrastructure.	• cost/benefit methodologies; • risk-sharing models; • methods for pricing resource transactions; • investment-assessment frameworks.

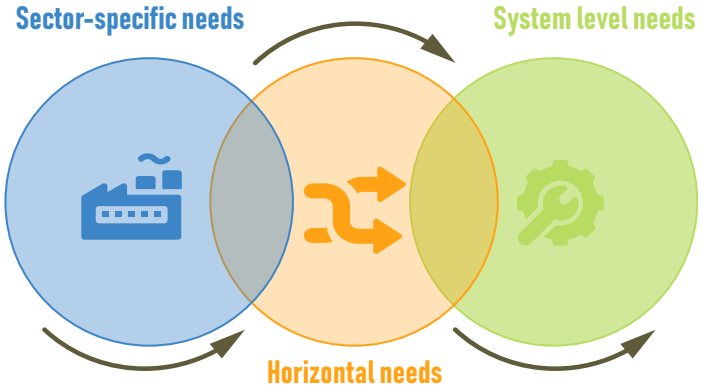
The tables are intended as a reference and orientation tool, not as a closed list. Projects should assess which needs are relevant to their specific context and consider whether additional or emerging needs have arisen. For further detail refer to the Industrial Symbiosis Standardisation Roadmap and the Map of Standardisation-Related R&I Needs.

Consider links between different R&I needs

Industrial Symbiosis is inherently systemic: technical solutions, data, organisations, infrastructure and framework conditions are interdependent. For this reason, R&I needs should not be considered in isolation.

A sector-specific challenge may require horizontal terminology, data structures or measurement approaches, while successful implementation may also depend on system-level factors such as governance, infrastructure, contracting or information sharing.

The project should therefore look beyond the primary R&I need and identify what other elements of the wider system may enable, constrain or influence the proposed solution.



Use a systems-thinking perspective to identify dependencies between needs at different levels and ensure that the R&I activity addresses not only the immediate need, but also the wider conditions required for the solution to work, transfer and scale.

Questions to ask

- What other R&I needs are connected to the primary need?
- Does the solution depend on common terminology, data or measurement approaches?
- Are there sector-specific technical requirements that must also be addressed?
- Which organisational, infrastructural, regulatory or governance conditions could affect implementation?
- Could addressing one need create new requirements or dependencies elsewhere in the system?

Questions to ask



Use of waste heat

Sector-specific need: methods for measuring and assessing waste-heat availability, temperature characteristics and recovery performance in relevant industrial applications.

Horizontal need: common descriptors, measurement boundaries and interoperable energy-data structures that allow heat data to be compared and exchanged.

System-level need: infrastructure and spatial-planning methodologies for assessing whether heat producers and users can be technically and geographically connected.



Second life batteries

Sector-specific need: reliable methods for assessing battery State of Health, Remaining Useful Life and suitability for second-life applications.

Horizontal need: common data fields, terminology, traceability information and interoperable data structures for describing battery condition and history.

System-level need: governance and information-sharing arrangements that allow relevant battery data to be accessed and used across organisations.

Formulate potential standardisation-related challenge

3.

Not every industrial symbiosis challenge requires standardisation. At this stage, the project should define what would benefit from a sufficiently common approach and why this matters beyond the individual project, company or use case.

The challenge defined at this stage is still provisional. In Step 4, it should be checked against the existing standardisation landscape to determine whether the issue is already covered, partly addressed, currently being worked on, or represents a genuine gap.

Questions to ask

- What is currently defined or interpreted differently?
- What cannot be compared consistently?
- Where is interoperability lacking or inconsistent?
- What cannot be measured, tested or characterised consistently?
- Where are quality, performance or acceptance criteria missing or inconsistent?
- Where is the available evidence insufficient to support a common approach?
- What prevents the approach from being applied or transferred beyond the original setting?
- Does the problem occur beyond one project or company?
- Is it linked to other horizontal, sector-specific or system-level R&I needs identified earlier?

When may a challenge be standardisation-relevant?

A standardisation-relevant challenge may exist where different actors need a sufficiently common approach to::

- Communicate and use common terminology
- Compare results or resource characteristics
- Exchange data or transact resources
- Measure or assess performance consistently
- Replicate an approach in different settings

Example

Stan4SWAP

Standardising swappable battery systems for L-category vehicles

The Horizon Europe project focused on swappable battery systems for L-category vehicles and their integration into the wider e-mobility ecosystem. Its work was linked to the evolving policy and standardisation context, including the EU Battery Regulation and the Alternative Fuels Infrastructure Regulation

Standardisation challenge addressed:

Swappable battery systems involve vehicles, batteries and swapping stations that may be supplied by different manufacturers and operators. Without common requirements, these elements may not function together consistently.

The standardisation challenge is therefore to establish common interoperability and compatibility requirements that enable batteries, vehicles and swapping stations from different manufacturers to work together reliably and safely.

More project details: https://stan4swap.standards.eu/

Analyse the existing standardisation landscape

This step establishes the standardisation baseline before deciding what the project should develop, test or validate. The potential standardisation-related challenge formulated in Step 3 is still provisional and should now be checked against the existing standardisation landscape. Review what already exists, what is under development and what remains missing. This includes relevant standards and specifications, Technical Committees and Working Groups, test and assessment methods, regulatory requirements, and relevant results from completed or ongoing R&I projects.

The baseline should clarify whether the identified need is already covered, partly addressed, currently being worked on, or represents a genuine gap. This provides the basis for deciding in Step 5 what the R&I activity should actually provide.

Example

FISSAC

Fostering Industrial Symbiosis For A Sustainable Resource Intensive Industry Across The Extended Construction Value Chain

FISSAC project developed and demonstrated solutions applicable to industrial symbiosis across the construction value chain, linking sectors such as steel, aluminium, ceramics, natural stone, chemicals, demolition and construction.

FISSAC analysed the existing standardisation landscape relevant to its technologies, reviewing standards, Technical Committees and ongoing work. This helped identify what was already covered, where gaps remained and which Technical Committees were relevant to the project's results.

Why this matters:
Defining the baseline helped FISSAC position its R&I results within existing standardisation work and identify where the project could contribute.

Further reading: *FISSAC D2.6 – Report on the Contribution to the Standardisation System regarding FISSAC technologies*

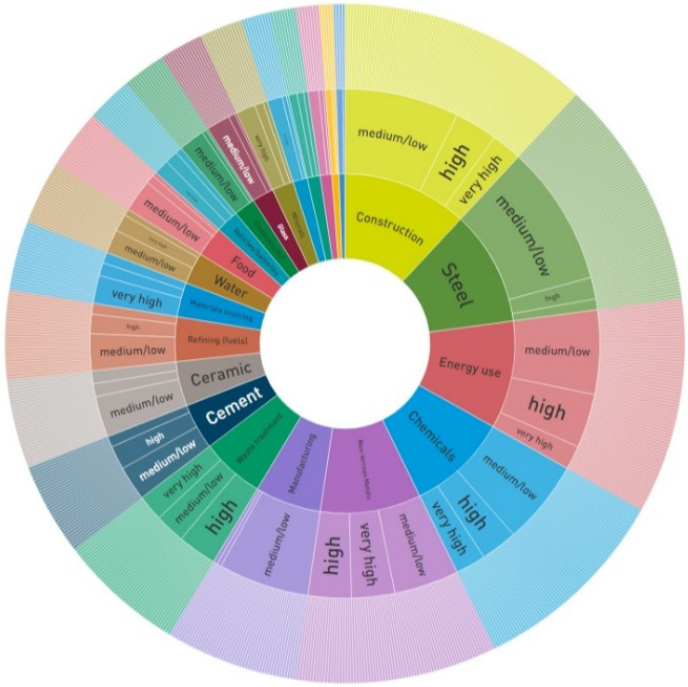
RISERS tools supporting baseline definition

Map of Current R&I Activities Related to the Priorities for IS Standardisation

Provides an overview of European R&I projects relevant to Industrial Symbiosis standardisation. More than 150 projects were screened and 21 highly relevant projects were analysed in terms of their relevance to technologies, standards and policy, helping identify existing results and remaining R&I gaps

RISERS Tool for Technical Committees Mapping

Maps European and international Technical Committees against key industrial symbiosis sectors and indicates their estimated relevance, helping projects identify potentially relevant TCs for further standardisation landscape analysis.



4.

Revisit Map of Current R&I Activities Related to the Priorities for Industrial Symbiosis Standardisation

Consult the Tool:

5. Define what R&I should provide

Once the standardisation baseline is clear, the project should define what concrete output the R&I activity is expected to produce. This may be a direct technical input to standardisation, a standardisation-supporting output, or an enabling framework or condition that helps common approaches to be developed, applied or scaled.

At this stage, move from a broad research topic to a specific output that the project will actually produce — for example, a method, dataset, protocol, criteria, specification, assessment approach or evidence package — and that can be developed, tested, validated and used beyond the project itself.

Direct contributions to standardisation

Outputs that could provide direct technical input to existing or potential future standardisation work, e.g.:

- terminology, definitions and classifications;
- measurement, sampling, test or characterisation methods;
- KPIs and assessment methodologies;
- quality, performance or acceptance criteria;
- data, interoperability and traceability requirements;
- verification or conformity-assessment approaches;
- technical requirements or protocols

Standardisation-supporting outputs

Outputs that create the technical and evidence base which may support standardisation e.g.:

- representative or reference datasets;
- comparative analyses of methods or approaches;
- reference test cases and benchmark scenarios;
- validation or test protocols;
- interoperability testing;
- documented operating ranges, limitations and boundary conditions;
- technical reports or structured evidence packages supporting future standardisation.

Enabling frameworks and conditions relevant to standardisation

Outputs that may not themselves become standardisation deliverables, but can support the development, application or uptake of common approaches e.g.:

- competence frameworks and training requirements;
- governance and information-sharing frameworks;
- approaches to roles, responsibilities and liability;
- infrastructure or spatial-planning criteria;
- organisational or institutional arrangements;
- evidence supporting regulatory alignment.

Projects & Outputs Examples

SHAREBOX resulted in a formal IS standardisation deliverable: CWA 17354:2018, which provides a common framework for IS, including terminology, core elements and implementation approaches.

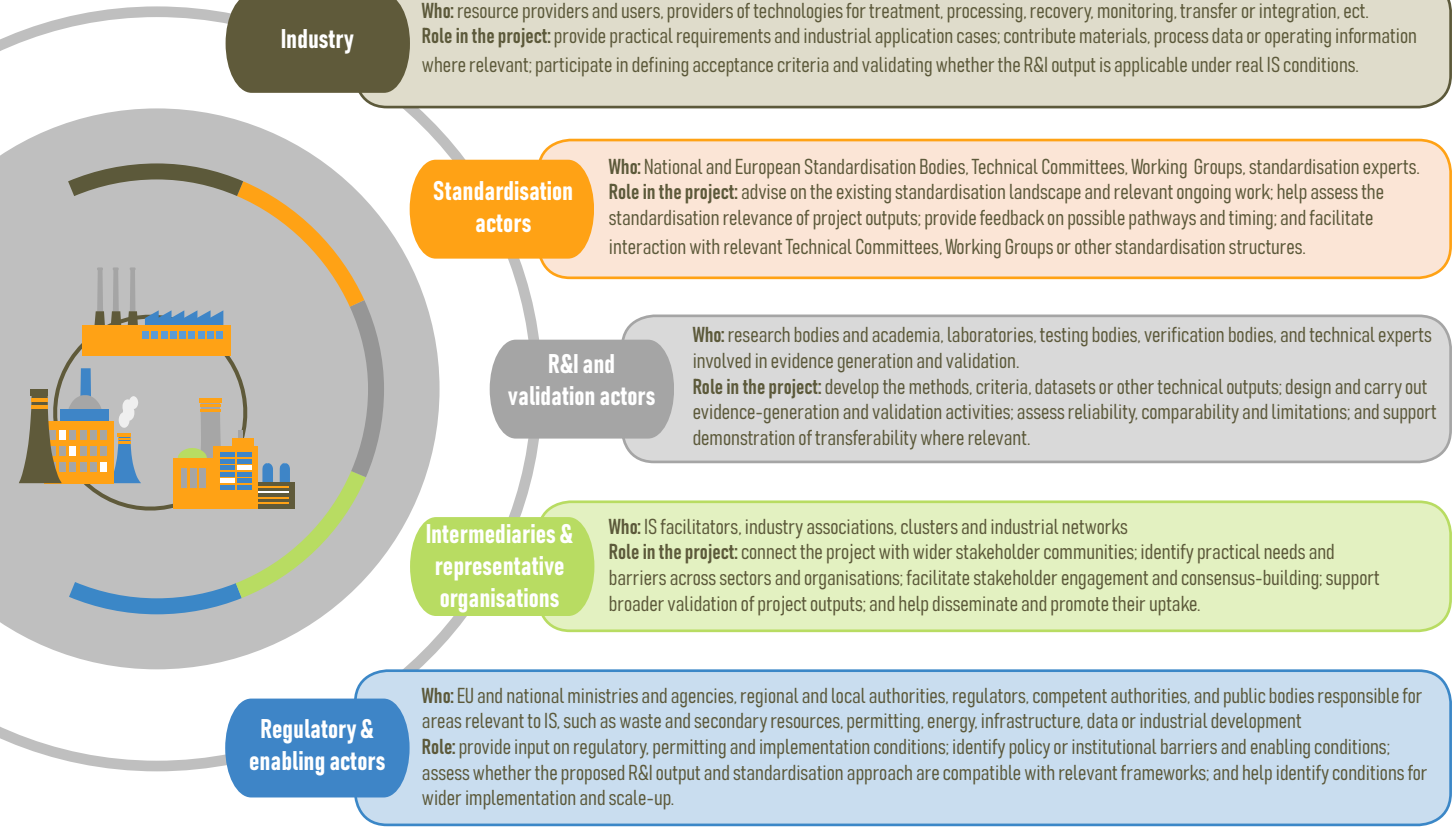
CIRC-PACK generated validated evidence, protocols and assessment approaches for circular plastic packaging, including compostability, recycling and circularity performance, and analysed how these results relate to existing and future standardisation.

INSET delivered capacity-building methodology and training framework for IS, supporting the skills and organisational capacity needed for implementation and scale-up.

Identify & menage relevant stakeholders

Industrial symbiosis involves a diverse set of stakeholders who may play different roles in relation to the development, validation, standardisation and wider uptake of an R&I output, as illustrated in the diagram. The relevant stakeholders to be engaged depend on the type of R&I output, the horizontal, sector-specific and system-level needs linked to it, and the contribution required to take that output forward. Stakeholder identification should therefore consider who the potential users, adopters and beneficiaries of the R&I output are, what needs or requirements they have, and how the intended standardisation of the output could help address those needs and support its uptake and wider application.

Industrial symbiosis standardisation stakeholders



Industry

Who: resource providers and users, providers of technologies for treatment, processing, recovery, monitoring, transfer or integration, ect.
Role in the project: provide practical requirements and industrial application cases; contribute materials, process data or operating information where relevant; participate in defining acceptance criteria and validating whether the R&I output is applicable under real IS conditions.

Standardisation actors

Who: National and European Standardisation Bodies, Technical Committees, Working Groups, standardisation experts.
Role in the project: advise on the existing standardisation landscape and relevant ongoing work; help assess the standardisation relevance of project outputs; provide feedback on possible pathways and timing; and facilitate interaction with relevant Technical Committees, Working Groups or other standardisation structures.

R&I and validation actors

Who: research bodies and academia, laboratories, testing bodies, verification bodies, and technical experts involved in evidence generation and validation.
Role in the project: develop the methods, criteria, datasets or other technical outputs; design and carry out evidence-generation and validation activities; assess reliability, comparability and limitations; and support demonstration of transferability where relevant.

Intermediaries & representative organisations

Who: IS facilitators, industry associations, clusters and industrial networks
Role in the project: connect the project with wider stakeholder communities; identify practical needs and barriers across sectors and organisations; facilitate stakeholder engagement and consensus-building; support broader validation of project outputs; and help disseminate and promote their uptake.

Regulatory & enabling actors

Who: EU and national ministries and agencies, regional and local authorities, regulators, competent authorities, and public bodies responsible for areas relevant to IS, such as waste and secondary resources, permitting, energy, infrastructure, data or industrial development
Role: provide input on regulatory, permitting and implementation conditions; identify policy or institutional barriers and enabling conditions; assess whether the proposed R&I output and standardisation approach are compatible with relevant frameworks; and help identify conditions for wider implementation and scale-up.

Plan stakeholder involvement according to the role each group is expected to play in the project and the contribution needed for the R&I output. Engagement may need to change over the course of project development and implementation as requirements are refined, evidence is generated, outputs are validated, and standardisation or uptake pathways become clearer.

Examples

Baltic Industrial Symbiosis (BIS)

The BIS project developed .

- The Guidebook for IS Living Lab providing methods for participatory collaboration, co-creation and collaborative testing of IS solutions.
- Guide for IS Facilitators providing practical guidance on facilitating stakeholder collaboration, identifying resource synergies and developing industrial symbiosis partnerships

Scaling European Resources With Industrial Symbiosis

SCALER project developed a report Pathways to Increase Industrial Symbiosis Implementation which provides practical tools and methods to support stakeholder engagement and development of industrial symbiosis initiatives.

6.

Consult the Key policy stakeholders for Industrial Symbiosis

Examples of stakeholders engagement methods

Stakeholder engagement methods should be selected according to the R&I output to be developed, the contribution expected from the stakeholders involved, and the purpose of the engagement.

Different methods may support the project in defining needs and requirements, jointly developing and validating R&I outputs, building convergence around proposed approaches, and connecting project results with relevant standardisation activities.

The examples below are not a fixed sequence. Methods may be combined or revisited during proposal development and project implementation, depending on the R&I output, the evidence required and the role of the stakeholders involved..

UNDERSTAND & FRAME

System mapping

Understand actors, resource flows, interfaces interdependencies and barriers

Example methods:

- facilitated mapping workshops
- stakeholder interviews
- actor / network mapping
- resource-flow mapping
- value-chain mapping

Co-design

Jointly define the R&I problem, stakeholder requirements, priorities and expected outputs

Example methods:

- co-design workshops
- focus groups
- problem-framing sessions
- priority-setting exercises
- stakeholder interviews

CO-DEVELOP & VALIDATE

Co-creation

Jointly develop methods, criteria, frameworks, protocols or other R&I outputs

Example methods:

- co-creation workshops
- thematic working groups
- challenge labs
- joint development sessions
- collaborative prototyping
- expert roundtables

Living labs / collaborative validation

Assess the applicability and performance of R&I outputs in representative or real-world settings

Example methods:

- living labs
- pilot demonstrations
- field trials
- collaborative testing & validation campaigns
- user / practitioner observation
- feedback sessions
- cross-sector case studies

ALIGN & BUILD CONSENSUS

Consensus building

Build convergence around terminology, requirements, criteria, evidence or other proposed common approaches

Example methods:

- Delphi questionnaires
- expert panels
- structured surveys
- ranking / scoring exercises
- consensus workshops

Structured liaison / knowledge brokerage

Create a structured interface between the project and relevant standardisation actors to connect outputs with standardisation work

Example methods:

- joint R&I–TC/WG workshops
- technical briefings to TCs/ WGs
- project liaison arrangements
- participation of standardisation experts in project working groups
- Targeted ad-hoc expert meetings
- structured review rounds

Plan the evidence needed

The R&I output is what the project develops — for example, a method, technology, dataset, protocol, criteria, specification, assessment approach or framework. The evidence is what demonstrates that this output is sufficiently substantiated, reliable and applicable for its intended use — for example, comparative data, validation results, stakeholder assessment, representative application cases, or documented limitations and boundary conditions. The type of evidence needed therefore depends on the R&I output defined in Step 5, its intended use, maturity and the context in which it is expected to be applied.

For each type of output, identify the evidence needed to show that it is sufficiently substantiated and reliable for its intended use. Where relevant, also plan evidence that demonstrates its applicability beyond the original project cases and supports its potential contribution to standardisation.

The examples below illustrate typical evidence-generation and validation actions that may be selected and combined for different types of outputs.

7.

1. Direct contributions to standardisation

Terminology, definitions and classifications

- review and compare existing terminology and classifications
- test proposed definitions against relevant use cases
- check consistency across sectors or applications
- validate with relevant experts and users
- resolve ambiguities or conflicting interpretations

Measurement, sampling, test or characterisation methods

- test methods using representative samples, materials or datasets
- assess repeatability and reproducibility
- determine measurement uncertainty, where relevant
- compare with existing or reference methods
- validate across laboratories, sites or operating conditions where appropriate

KPIs and assessment methodologies

- define scope, boundaries and calculation rules
- verify availability and quality of underlying data
- compare with existing approaches
- test sensitivity and robustness
- validate across representative cases

Quality, performance or acceptance criteria

- link proposed criteria to intended use
- generate data covering relevant variability
- define and justify thresholds, classes or limits
- test whether criteria distinguish relevant levels of performance
- validate under representative application conditions

Data, interoperability and traceability requirements

- define and test common data fields, descriptors and formats
- check data completeness, quality and consistent interpretation
- test data exchange across different systems or platforms
- assess interoperability and traceability in representative use cases
- validate requirements with relevant users and system providers

Verification or conformity-assessment approaches

- define what is to be assessed and against which requirements
- specify evidence, procedures and decision rules
- test the assessment approach on representative cases
- check consistency of assessment results between assessors or organisations
- validate feasibility and applicability with relevant users and assessment bodies

Technical requirements or protocols

- define the technical requirements, procedures and conditions of use
- test requirements under representative operating conditions
- assess whether requirements are measurable and verifiable
- identify limitations, dependencies and boundary conditions
- validate the protocol across relevant applications or users

2. Standardisation-supporting outputs

- generate representative datasets, samples or reference cases
- compare alternative methods or approaches
- carry out interoperability, multi-site or inter-laboratory testing or comparison where relevant
- document operating ranges, limitations and boundary conditions
- compile results into structured technical evidence packages

3. Enabling frameworks and conditions relevant to standardisation

- assess proposed roles, procedures or governance arrangements with relevant actors
- validate competence or training requirements with intended users
- assess applicability across organisations or contexts
- identify regulatory, institutional or organisational constraints
- document conditions needed for wider implementation or uptake

8.

Build and demonstrate transferability for potential standardisation

Transferability should be considered throughout project development and implementation, not only assessed once the R&I work is complete. Choices concerning demo sites, use cases, validation conditions, stakeholder groups and data environments influence whether the project can generate evidence showing that the R&I output can be applied beyond the cases directly covered.

For potential standardisation, the objective is not to demonstrate that an output works everywhere, but to establish whether it can support a common approach within an appropriate field of application, under defined conditions and with clearly understood limitations.

Transferability dimensions

Project validation context

What range of contexts and conditions has the project already covered in developing and validating the output??

- demo sites and use cases included
- sectors, technologies and resource streams represented
- geographical and regulatory contexts covered
- organisations, users and operating conditions represented



Across technical contexts

Can it work under different technical conditions?

- different installations
- technologies
- operating conditions
- resource qualities or types



Across sectors / applications

Can it be applied across different sectors of IS applications ?

- different use cases within one sector
- different sectors, where relevant
- different IS applications



Across organisations / users

Can it be applied by different organisations or users?

- different companies
- different users
- different IS partnerships



Across data environments

Can the output be applied when data sources, structures or systems differ?

- different data sources
- different data structures or formats
- different digital systems / platforms
- varying data quality, completeness and interoperability requirements



Across regulatory / regional contexts

Can it be applied in other regulatory or regional settings?

- different regional or national contexts
- different regulatory frameworks and requirements
- different institutional arrangements
- different permitting, policy or implementation conditions

Transferability for potential standardisation

Is Is the output sufficiently transferable to support a common approach beyond the project cases?

- demonstrates applicability beyond individual demos or project partners
- covers the range of users, applications and conditions relevant to the intended use
- identifies which elements are transferable and which remain context-specific
- defines limitations, boundary conditions and conditions of use

Not all transferability dimensions are equally relevant to every R&I output. Focus on those that matter for the type of output and its intended use — for example, transferability across digital systems may be less relevant to terminology, while regulatory or institutional transferability may be critical for enabling frameworks. Consider the relevant dimensions early enough to reflect them in the project's validation activities.

Link the R&I output to possible standardisation pathway

9.

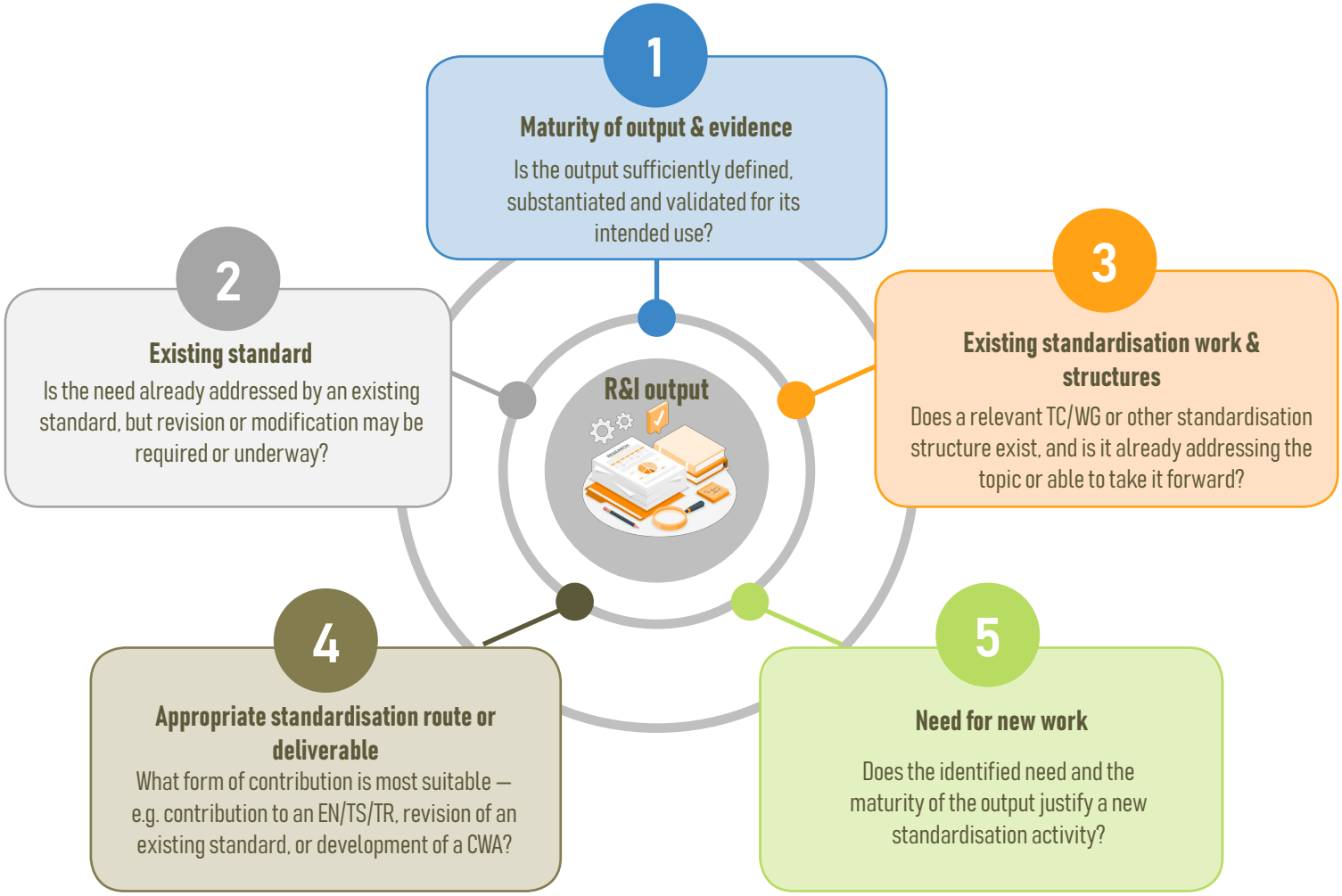
There is no single pathway through which an R&I output can contribute to standardisation. The diagram illustrates the 5 main factors that should be considered when deciding how an R&I output can be taken forward through an appropriate and realistic standardisation pathway.

These factors are generic to the use of R&I results in standardisation, but are applied here to the IS-related output, supporting evidence and transferability developed through the previous steps.

The assessment should consider the maturity of the output and supporting evidence, the existing standardisation landscape, the availability of relevant standardisation structures, and opportunities to align with ongoing standard development or revision processes.

Depending on this assessment, different situations may arise, leading to different standardisation-related next steps, as shown on the following page. The project should use this assessment to select the pathway that best matches the maturity of the output, the available evidence and the existing standardisation context

What determines the standardisation pathway?

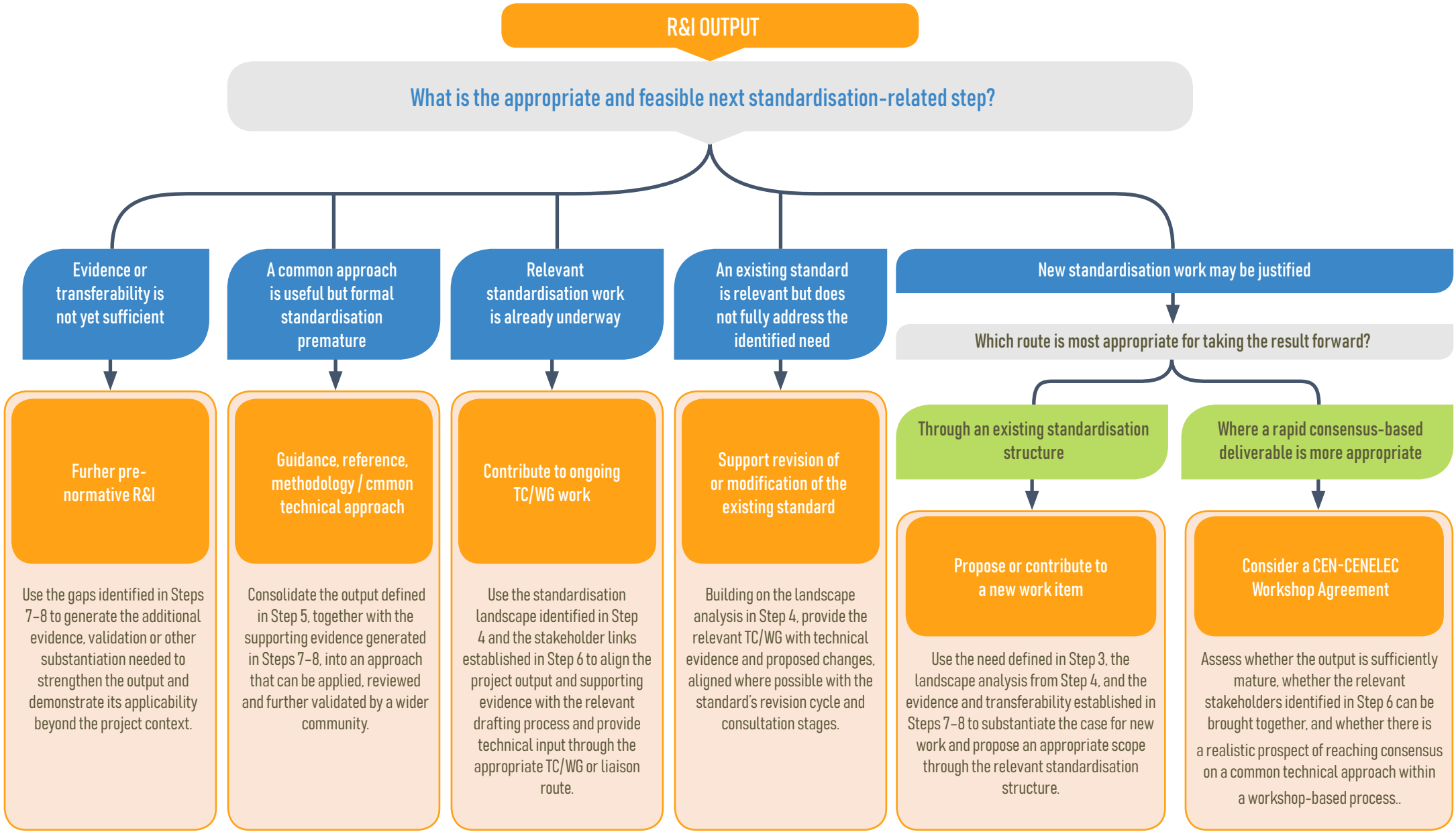


Revisit the standardisation landscape analysed in Step 4 and consider relevant standardisation timelines. Where the project intends to contribute to the revision of an existing standard, align project activities, evidence generation and delivery of technical input with the relevant revision cycle and drafting or consultation stages. A technically strong contribution may have limited impact if it becomes available too late in the process.

Illustration by Storyset.

Possible routes from R&I to standardisation

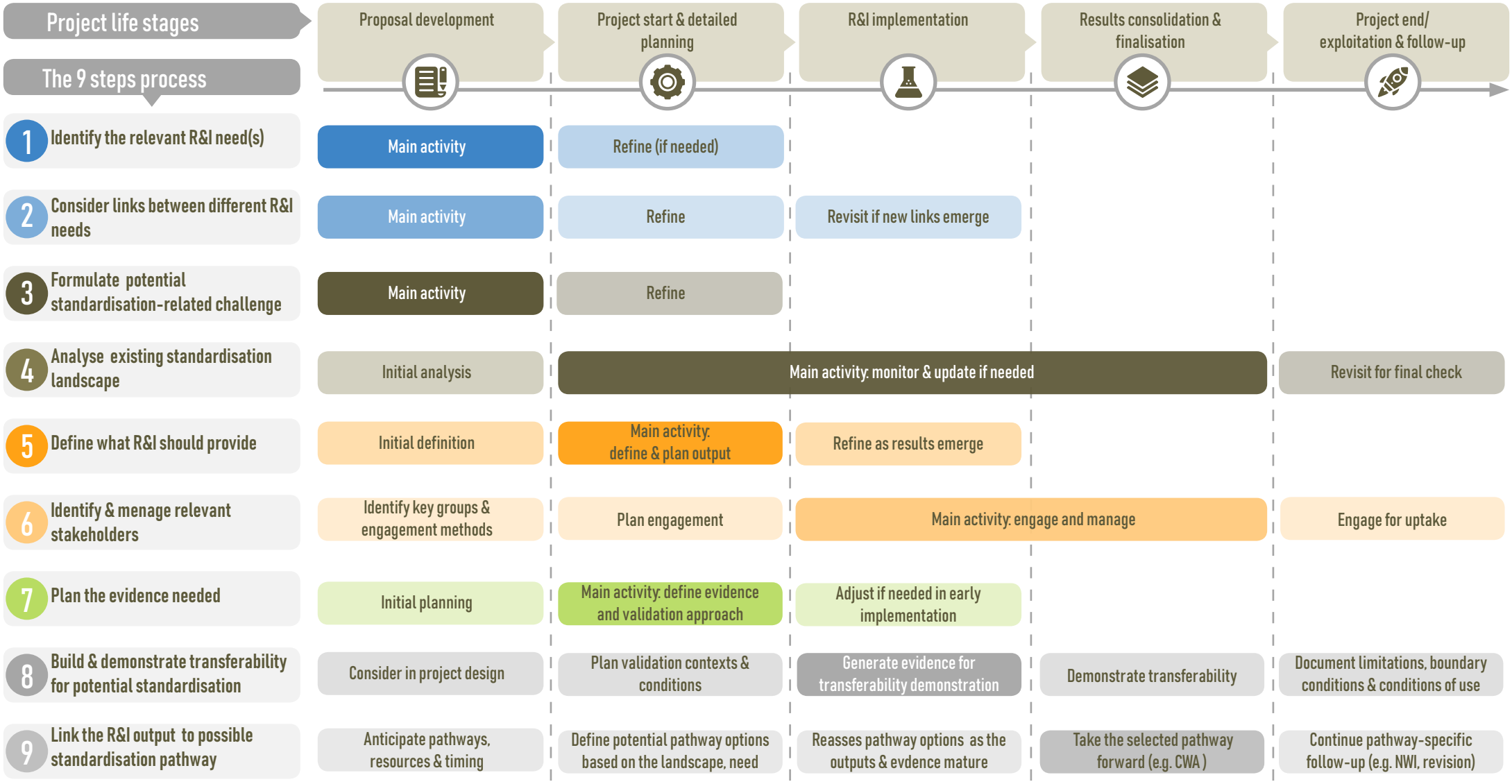
The diagram shows how different situations identified through the Step 9 assessment can lead to different next steps for taking an R&I output forward towards standardisation. The project should consider which of these routes provides the most appropriate standardisation-related valorisation or exploitation pathway for the R&I output, taking into account its maturity, the supporting evidence and the existing standardisation context.



Integrating the 9 steps across the project lifecycle

The steps can be integrated across the project lifecycle rather than applied as a one-off sequence. Some are particularly important during proposal development and project planning, while others become more prominent as the R&I output, supporting evidence and standardisation context evolve. The diagram below illustrates how the steps may be positioned and revisited across a typical project lifecycle.

The lifecycle mapping used in the diagram is indicative rather than prescriptive. The timing and intensity of each step should be adapted to the type of project, the R&I output, its maturity and the standardisation context.



Useful Resources

EU POLICY & RESEARCH FRAMEWORK

- European Commision. Code of practice on standardisation in the European Research Area. Commission Recommendation (EU) 2023/498 of 1 March 2023
- Horizon Europe (HORIZON) HE Programme Guide. 2025

STANDARDISATION GUIDANCE & TOOLS

- CEN-CENELEC Guide 23 Research Consortium Bridge- Addressing Research and Innovation in European Standardization activities and deliverables
- CEN-CENELEC Guide 29 CEN and/or CENELEC Workshop Agreements – A rapid way to standardisation
- CEN Workshop Agreement CWA 17354:2018
- Standards+Innovation - a European platform. https://www.standardsplusinnovation.eu/

RISERS OUTPUTS & RECOMMENDATIONS

- D 7.1 Roadmap for Industrial Symbiosis Standardisation (CEN, 2026)
- D 4.1 Map of current R&I activities related to the priorities for Industrial Symbiosis Standardisation (ISQ, 2025)
- D 4.3 Map of standardization related R&I needs (ISQ, 2026), including Annexes 1-2
- D 5.1 Key policy stakeholders for Industrial Symbiosis
- D 6.1 Mapping of European and International Technical Bodies relevant for Industrial Symbiosis

RELATED PROJECTS & PRACTICAL RESOURCES

- H4C project – Hubs for circularity.
  - H4C Knowledge Platform. https://www.h4c-community.eu/knowledge-platform/
- BIS project— Baltic Industrial Symbiosis.
  - The Guidebook for IS Living Lab — Lovisa Grönlund & Souzan Youssouf, Usify (2021). https://symbiosecenter.dk/wp-content/uploads/2021/09/Living-Lab-report_Paper-Province.pdf
  - Guide for Industrial Symbiosis Facilitators — Dansk Symbiose Center (2021). https://symbiosecenter.dk/wp-content/uploads/2021/03/Guide-for-IS-facilitators_online.pdf
- CIRC-PACK project — Towards circular economy in the plastic packaging value chain.
- INSET project — Industrial Symbiosis for Businesses.
- STAN4SWAP project — Standardising swappable battery systems for L-category vehicles.
- FISSAC project - Fostering Industrial Symbiosis For A Sustainable Resource Intensive Industry Across The Extended Construction Value Chain.
  - Report on the Contribution to the Standardisation System regarding FISSAC technologies https://fissacproject.eu/wp-content/uploads/2017/12/FISSAC-D2.6-Contribution-to-standardization-System-regarding-FISSAC-tech.pdf
- SCALER project - SCALing European Resources with industrial symbiosis.
  - Report: Pathways to Increase Industrial Symbiosis including tools & methods for stakeholders (2019). https://www.scalerproject.eu/wp-content/uploads/2021/03/D2.4_SCALER_Pathways-to-increase-Industrial-Symbiosis-implementation_v2.0.pdf
- SHAREBOX project — Secure Management Platform for Shared Process Resources.

RISERS Community on ZENODO

The RISERS Community on Zenodo, accessible via the link and QR code below, provides access to public resources produced by the project, including reports and deliverables, posters, factsheets and other publications on industrial symbiosis and standardisation.

- https://zenodo.org/communities/risers/

List of Acronyms

Acronym	Explanation
CEN	European Committee for Standardisation
CENELEC	European Committee for Electrotechnical Standardisation
CWA	CEN/CENELEC Workshop Agreement
EN	European Standard
EU	European Union
IS	Industrial Symbiosis
KPI	Key Performance Indicator
NWI	New Work Item
R&I	Research and Innovation
RUL	Remaining Useful Life
SoH	State of Health
TB	Technical Body
TC	Technical Committee
TR	Technical Report
TS	Technical Specification
WG	Working Group

Glossary

Terms related to the guide concepts

Boundary conditions

Technical, operational, organisational, regulatory or other conditions that define where, when and under what circumstances an R&I output can be validly applied.

Evidence generation

Planned activities through which a project produces the information needed to substantiate, assess or validate an R&I output. Depending on the output, this may include testing, measurement, comparison, modelling, stakeholder assessment, multi-site or inter-laboratory work, or validation in representative application contexts.

Exploitation

The use of project results in further research and innovation activities other than those covered by the action concerned, including commercial exploitation such as developing, creating, manufacturing and marketing a product or process, creating and providing a service, or use in standardisation activities.

Source: Horizon Europe Programme Guide, section "Dissemination and exploitation of research results"; Horizon Europe rules for participation.

Knowledge valorisation

The process of creating social and economic value from knowledge by linking different areas and sectors and transforming data, know-how and research results into sustainable products, services, solutions and knowledge-based policies that benefit society.

Source: European Commission, EU knowledge valorisation policy / Council Recommendation (EU) 2022/2415 on the guiding principles for knowledge valorisation.

R&I need

A knowledge, methodological, technical or enabling gap that requires research and innovation to support the development, application or scale-up of Industrial Symbiosis and, where relevant, its standardisation.

R&I output

A concrete result produced by an R&I activity that can be applied, assessed, tested, validated or further developed, such as terminology, a method, dataset, protocol, criteria, specification, assessment approach, technical requirement, evidence package or framework.

Result

Any tangible or intangible effect of an action, such as data, know-how or information, whatever its form or nature, whether or not it can be protected, together with any rights attached to it, including intellectual property rights.

***Note:** Result is the term used in Horizon Europe. In this guide, **R&I output** is used to refer to the specific project result being developed and considered for a potential contribution to standardisation.*

Source: Horizon Europe Programme Guide; Regulation (EU) 2021/695; Horizon Europe Model Grant Agreement.

Standardisation baseline

The project's documented understanding of the relevant standardisation landscape at a given point in time, used to establish what is already covered, partly addressed, under development or still missing and to inform what the R&I activity should provide.

Standardisation landscape

The existing and emerging standardisation context relevant to an R&I activity, including applicable standards and specifications, relevant Technical Committees and Working Groups, ongoing standardisation work, test and assessment methods, related regulatory requirements and relevant results from completed or ongoing R&I activities.

Standardisation pathway

The route through which an R&I output may be taken forward in relation to standardisation. Depending on the maturity of the output, supporting evidence and existing standardisation landscape, this may involve further pre-normative R&I, development of guidance or a reference methodology, contribution to ongoing standardisation work, revision of an existing standard, development of a CEN/CENELEC Workshop Agreement, or initiation of new standardisation work.

Informed by CEN-CENELEC Guide 23:2020.

Standardisation-relevant challenge

A problem for which different actors would benefit from a sufficiently common approach and which extends beyond an individual project, organisation or use case. It may concern, for example, inconsistent terminology, lack of comparability, interoperability problems, inconsistent measurement or testing, missing criteria or insufficient evidence for a common approach.

Supporting evidence

Data, analyses, test results, validation results, stakeholder assessments, representative application cases or other information that substantiates an R&I output and demonstrates that it is sufficiently reliable and applicable for its intended use.

Transferability

The extent to which an R&I output can be applied beyond the original project cases within an appropriate field of application, under defined conditions and with its limitations, boundary conditions and context-specific elements understood.

Validation

The process of assessing whether an R&I output is sufficiently suitable, reliable and applicable for its intended use under defined conditions and, where relevant, across representative users, applications, sites, systems or other contexts.

Terms related to standardisation

CEN/CENELEC Workshop

A temporary group open to the participation of interested parties established for the development of one or more CEN and/or CENELEC Workshop Agreements.

Source: CEN-CENELEC Guide 29:2024, Clause 2.1.

CEN/CENELEC Workshop Agreement (CWA)

A CEN and/or CENELEC deliverable developed by a CEN and/or CENELEC Workshop that reflects agreement between the identified individuals and organisations responsible for its content. A CWA is developed outside the normal Technical Committee structure and can provide a relatively rapid route for establishing a consensus-based reference document, particularly in innovative or emerging areas. It is not a European Standard.

Source: CEN-CENELEC Guide 29:2024, Clauses 2.2 and 3.

Consensus

General agreement characterised by the absence of sustained opposition to substantial issues by an important part of the interests concerned and by a process seeking to take into account the views of all parties concerned and to reconcile conflicting arguments. Consensus does not necessarily imply unanimity.

Source: terminology used within the European and international standardisation system; CEN-CENELEC standardisation rules / EN 45020.

European Standard (EN)

A standard adopted by CEN and/or CENELEC that CEN/CENELEC Members are required to implement nationally as an identical national standard and for which conflicting national standards are withdrawn.

Source: CEN-CENELEC Internal Regulations – Part 2.

New Work Item (NWI)

A new item of standardisation work formally introduced into the work programme of a CEN or CENELEC Technical Body following the relevant approval procedure. It may concern the development of a new standardisation deliverable or other new technical work.

Source/basis: CEN-CENELEC Internal Regulations – Part 2; CEN-CENELEC Guide 23:2020, Clause 2.4.3.

Pre-normative research / R&I

Research and innovation undertaken to generate scientific, technical or other evidence needed to prepare or support future standardisation. It is particularly relevant where the evidence base is not yet sufficiently mature for standardisation work to progress.

Source/basis: CEN-CENELEC Guide 23:2020, Clause 2.4.3.

Project Liaison

A mechanism through which an R&I project can establish structured cooperation with a relevant CEN/CENELEC Technical Body and contribute project knowledge, expertise and results to its work.

Source/basis: CEN-CENELEC Guide 23:2020, Clauses 2.3–2.4; CEN-CENELEC rules on cooperation and liaison.

Revision

The formal process of reviewing and modifying an existing standardisation deliverable in order to update its content and, where appropriate, publish a new edition. R&I results and evidence can provide technical input supporting the need for, or content of, a revision.

Source/basis: CEN-CENELEC Internal Regulations – Part 2; CEN-CENELEC Guide 23:2020, Clause 2.4.3.

Standard

A document established by consensus and approved by a recognised body that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results and is aimed at achieving an optimum degree of order in a given context.

Source: CEN-CENELEC Internal Regulations – Part 3, definition of "standard"; EN 45020.

Standardisation

The activity of establishing, with regard to actual or potential problems, provisions for common and repeated use aimed at achieving the optimum degree of order in a given context. Standardisation includes, in particular, the processes of formulating, issuing and implementing standards.

Source: European/international standardisation terminology, EN 45020 / ISO/IEC Guide 2.

Standardisation deliverable

A document or other output developed and approved within the CEN/CENELEC system according to the rules applicable to the particular type of deliverable. CEN/CENELEC deliverables include European Standards (EN), Technical Specifications (TS), Technical Reports (TR) and CEN/CENELEC Workshop Agreements (CWA).

Source/basis: CEN-CENELEC Internal Regulations – Part 2; CEN-CENELEC Guide 29:2024.

Technical Body (TB)

A body established within CEN or CENELEC to develop and manage technical standardisation work. Technical Committees, Subcommittees and Working Groups are examples of structures involved in the technical work of CEN and CENELEC.

Source/basis: CEN-CENELEC Internal Regulations – Part 2.

Technical Committee (TC)

A CEN or CENELEC Technical Body responsible for a defined field of standardisation and for developing and managing the relevant programme of standardisation work.

Source: CEN-CENELEC Internal Regulations – Part 2.

Technical Report (TR)

An informative CEN/CENELEC deliverable containing material that is not suitable for publication as a European Standard or Technical Specification, for example information on technical developments, data or other material useful to the standardisation community.

Source: CEN-CENELEC Internal Regulations – Part 2.

Technical Specification (TS)

A CEN/CENELEC deliverable containing technical requirements for which there is the possibility of future agreement on a European Standard but where, at the time of publication, the conditions for developing an EN are not yet fulfilled.

Source: CEN-CENELEC Internal Regulations – Part 2.

Working Group (WG)

A group established by a CEN or CENELEC Technical Body to undertake specific technical work, normally including the drafting or revision of standardisation documents.

Source: CEN-CENELEC Internal Regulations – Part 2.

RISERS

A Roadmap for Industrial Symbiosis Standardisation for Efficient Resource Sharing

RISERS is a Horizon Europe project supporting the wider uptake of industrial symbiosis through standardisation. RISERS identifies where standards can help overcome technical, organisational and cross-sector barriers to resource sharing, improve interoperability and trust, and support the transfer and scale-up of industrial symbiosis solutions. The project brings together evidence from industrial cases, R&I activities and stakeholder expertise to develop a European roadmap for industrial symbiosis standardisation, complemented by practical guidance, policy recommendations and other tools supporting implementation.

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