icarus

D5.3. Social Impact Framework

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List of Acronyms

AHP	Absorbent Hygiene Products
DC	Demonstration Case
DU	Declared Unit
FU	Functional Unit
GRI	Global Reporting Initiative
ICARUS	Increasing Circularity in Process Industries by Upcycling Secondary Resources
LAR	Lithium Aluminosilicate Residue
LCA	Life Cycle Assessment
PCC	Precipitated Calcium Carbonate
PSIA	Product Social Impact Assessment
SIA	Social Impact Assessment
S-LCA	Social Life Cycle Assessment
SROI	Social Return on Investment
SRM	Secondary Raw Material
SPD	Social Product Declaration
ToC	Theory of Change
UNEP	United Nations Environment Programme
WP	Work Package
WWTP	Wastewater Treatment Plant

Keywords list

Social Impact Assessment
Product Social Impact Assessment
PSIA
ICARUS
Circular Economy
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LAR
Lithium Aluminosilicate Residue
Steel Slag, Cellulose
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Disclaimer

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The framework presented herein is based on the Product Social Impact Assessment (PSIA) methodology developed by the Social Value Initiative (formerly the Roundtable for Product Social Metrics). Users of this framework should refer to the original PSIA Handbook, Methodology Report, and Social Topics Report for complete methodological details and guidance.

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While the authors have made reasonable efforts to ensure the accuracy and completeness of the content, this framework provides guidance and requires further population with specific data and context for each demonstration case within the ICARUS project. The application of this framework and the interpretation of results are the responsibility of the user.

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1. Executive summary

This document presents the Social Impact Framework (Deliverable 5.3) for the ICARUS project. Its purpose is to provide a structured methodology for assessing the social impacts associated with the project's activities, particularly the upcycling of secondary resources into new products within three Demonstration Cases (DCs): DC1 (Lithium Aluminosilicate Residue - LAR), DC2 (Cellulose from AHP and WWTP residues), and DC3 (Steel Slags).

The framework is based on the established Product Social Impact Assessment (PSIA) methodology. This choice was made after considering various approaches, favoring PSIA for its product-level focus, practicality for innovative systems, comprehensive stakeholder coverage, and ability to provide actionable insights directly relevant to ICARUS's objectives and demo-case structure. The document details the key stages of the PSIA methodology and establishes general assessment principles applicable across the project. These principles include how stakeholder identification for the SIA is informed by broader project stakeholder mapping (WP3, WP4), alongside allocation rules, cut-off criteria, and data quality requirements. It then provides dedicated chapters for defining the specific scope (Goal, Functional Unit, System Boundary) and identifying material topics for each DC. This structure ensures consistency while allowing for case-specific adaptation.

The primary goals of applying this framework are to identify social hotspots (both risks and opportunities), integrate social considerations into technology development, support informed decision-making within the project, enhance transparency, and fulfill project reporting requirements. This document establishes the methodological foundation; subsequent work within ICARUS will involve applying this framework through data collection (including stakeholder surveys for materiality assessment) and detailed assessment for each DC.

2. Introduction

This document presents the **Social Impact Framework** developed for the **ICARUS (Increasing Circularity in Process Industries by Upcycling Secondary Resources)** project. As **Deliverable 5.3**, this framework establishes a robust and systematic approach for identifying, assessing, and interpreting the potential social impacts—both positive and negative—arising from the project's activities. ICARUS aims to advance the circular economy by developing innovative pathways to upcycle challenging secondary resources, such as Lithium Aluminosilicate Residue (LAR) and steel slags, into valuable new products for sectors like construction and ceramics.

Given the project's focus on industrial transformation and resource circularity, understanding the social dimension is paramount. This involves considering effects on workers involved in new processes, potential impacts on communities near demonstration sites, implications for end-users, and broader societal contributions. Conducting a Product Social Impact Assessment (PSIA) ensures that social considerations are proactively integrated alongside environmental and economic aspects, supporting responsible innovation and contributing to a just transition towards a circular economy.

This framework is grounded in the established principles and detailed methodologies outlined by the Social Value Initiative (formerly the Roundtable for Product Social Metrics) in their *Product Social Impact Assessment Handbook* (2020), *Methodology Report* (2020), and *Social Topics Report* (2022). These resources provide a credible and widely recognized basis for the assessment. This document outlines general principles and then provides specific sections for applying these principles to each major Demonstration Case (DC).

3. General Information

3.1. Scope of the Framework

This framework applies to the assessment of social impacts related to the processes, technologies, and products developed and demonstrated within the ICARUS project. This includes, but is not limited to:

- The sourcing and processing of secondary raw materials (e.g., Lithium Aluminosilicate Residue, Steel Slags, Cellulose sources).
- The manufacturing processes involved in upcycling these materials.
- The demonstration cases (DCs) and pilot applications of the developed products (e.g., in construction materials, ceramics).
- Activities undertaken by project partners directly related to ICARUS objectives.

3.2. Goal of the Social Impact Assessment (Overall Project)

The Social Impact Assessment within ICARUS primarily seeks to identify potential positive and negative social effects across the project's value chain, encompassing raw material sourcing, product application, and end-of-life considerations for each Demonstration Case. It aims to integrate social factors into the development and deployment of circular economy solutions while informing project decisions, technology choices, and partner engagement strategies to enhance positive impacts and mitigate negative ones. Moreover, the assessment strives to provide transparent communication regarding the project's social performance, thereby engaging stakeholders effectively. In addition, it supports the project's overall sustainability evaluation, as outlined in this framework (D5.3) and further detailed in assessment reports for each Demonstration Case.

4. Methodology Selection: Rationale for Adopting PSIA for ICARUS

This chapter elaborates on the rationale for selecting the Product Social Impact Assessment (PSIA) methodology as the foundational framework for Social Impact Assessments (SIA) within the ICARUS project. It explores the specific needs of the project, reflects initially considered methodological influences, and explains how PSIA aligns with the project's goals and practical requirements.

The ICARUS project, focused on promoting circularity in process industries by upcycling secondary resources, naturally incurs social impacts across its value chains. Conducting a structured SIA is crucial to proactively identifying and managing potential social risks and opportunities. It ensures that the technologies and products developed under the project are not only environmentally and economically sustainable but also socially responsible and beneficial. Furthermore, the SIA framework supports the project's explicit goals concerning job creation, skills development, inclusivity, and the market adoption of socially responsible materials. A comprehensive SIA also enables effective stakeholder engagement, informed decision-making, and transparent communication. Additionally, it fulfills the project's commitment to establishing and implementing a social impact framework, as outlined in its Work Package 5 tasks.

4.1. Overview of Methodological Landscape for Social Impact Assessment

3.2.1 Product Social Impact Assessment (PSIA) - Key Features

The PSIA methodology, developed by the Social Value Initiative (formerly the Roundtable for Product Social Metrics), is specifically designed to assess the social impacts of products and services throughout their life cycle. Its key characteristics, which are particularly relevant to ICARUS, include:

Product/Service Focus: Tailored for assessing impacts at the product or service level.

Stakeholder-Centric: Identifies impacts on key groups (Workers, Users, Local Communities, Small-Scale Entrepreneurs).

Defined Social Topics & Indicators: Provides a structured list of social topics and qualitative/quantitative performance indicators.

Reference Scales: Uses a 5-point scale (-2 to +2) for performance assessment against benchmarks, often based on international standards or best practices.

Practicality & Business Relevance: Designed for implementability and actionable insights.

Hotspot Identification & Materiality: Includes processes to focus assessment efforts on the most significant issues.

4.2. Other Considered Approaches and the Broader S-LCA Context (B-Corp, GRI, SROI, ToC, UNEP S-LCA Guidelines)

The ICARUS project proposal (Task 5.3 description) initially indicated that the SIA framework would be informed by, or potentially hybridize, several other methodologies and guidelines. It's important to understand their scope to see why PSIA was chosen as the *core* SIA approach:

B-Corp Sustainability Self-Assessment: This tool is primarily for assessing the overall social and environmental performance of a *company* against rigorous standards of accountability and transparency. While valuable for organizational improvement, its focus is broader than the specific product/process innovations of ICARUS demo cases.

Global Reporting Initiative (GRI) Standards: GRI provides the most widely used standards for *sustainability reporting* by organizations on their economic, environmental, and social impacts. While GRI principles (e.g., materiality, stakeholder inclusiveness) are valuable and align with PSIA, GRI's primary output is a report, not a detailed product-level impact assessment methodology itself.

Social Return on Investment (SROI): SROI is a framework for measuring and accounting for a broader concept of value; it seeks to reduce inequality and environmental degradation and improve wellbeing by incorporating social, environmental, and economic costs and benefits, often through monetization. It is a powerful tool for understanding wider value but can be complex and data-intensive, particularly for quantifying and monetizing diverse social impacts of novel industrial processes within the project's initial phases.

Theory of Change (ToC): ToC is a methodology for planning, participation, and evaluation that is used to promote social change. It defines long-term goals and then maps backward to identify necessary preconditions. While useful for program design and strategic planning, it is not a standalone SIA methodology for product life cycles but rather a complementary approach to understand impact pathways.

UNEP Guidelines for Social Life Cycle Assessment of Products and Organizations (2020): These guidelines provide a comprehensive and valuable overarching framework for the entire field of S-LCA. They introduce concepts like Social Organizational LCA (SO-LCA) and detail advanced S-LCA methodologies, including Impact Pathway (Type II) S-LCIA, which aims to model detailed cause-and-effect chains quantitatively. While foundational for the S-LCA field, the full application of Type II S-LCIA can be highly complex and data-intensive, especially for novel and evolving systems like those in ICARUS.

4.3. Why PSIA is the Core Methodology for ICARUS

After careful consideration of ICARUS's specific needs – particularly the focus on assessing the social impacts of new products and processes emerging from its three distinct Demonstration Cases – the Social Life Cycle Assessment (S-LCA) PSIA methodology was chosen as the core SIA framework. This decision was influenced by the suitability of PSIA for product-level assessments, its practicality for innovative systems, and its ability to provide actionable insights.

ICARUS's main outputs are new upcycled materials and their applications. PSIA is explicitly designed for assessing impacts at the product/service level, making it directly applicable to evaluating the social footprint of LAR-derived ceramics, cellulose-enhanced concrete, or PCC from steel slags. In contrast, methodologies like B-Corp or GRI tend to prioritize organization-centric measures and lack the specificity required for ICARUS's objectives.

The flexible and structured nature of PSIA makes it ideal for assessing the novel and evolving technologies developed in ICARUS, where extensive quantitative social data may initially be scarce. Unlike complex methodologies such as SROI or Type II S-LCA from UNEP guidelines, PSIA allows meaningful performance and risk assessments even with emerging data. Its adaptability ensures that key social dimensions like worker health and safety, community relations, and user impacts are systematically addressed through tailored stakeholder categories and social topics.

PSIA is designed to yield actionable insights, directly informing decision-making, risk management, and the development of socially responsible products and business models – all critical for ICARUS's goals. Developed by an industry-led roundtable, it aligns with the practical demands of business applicability while maintaining rigour.

Moreover, while PSIA serves as the core methodology, tools and principles from other approaches complement its framework. The materiality principle from GRI guides the selection of social topics, and Theory of Change thinking is implicitly embedded in PSIA’s process of linking company activities to stakeholder impacts. Insights from SROI and B-Corp provide valuable perspectives for interpreting results or inspiring specific performance indicators. Though these methodologies are not the primary structure for ICARUS due to their complexity and broader scope, they could enhance the understanding of impacts in particular contexts.

PSIA’s alignment with life cycle thinking and stakeholder-centric principles emphasized by UNEP S-LCA Guidelines further underscores its relevance. By focusing on performance indicators and reference scales, PSIA operationalizes parts of a Type I S-LCA, offering a pragmatic first step before delving into more complex assessments like Type II S-LCIA. This balance of practicality, thoroughness, and adaptability establishes PSIA as the ideal choice for ICARUS’s social impact assessment framework.

5. PSIA Methodology: Key Stages and Guiding Principles for Application in ICARUS

This framework adheres to the methodology detailed in the following core documents:

Product Social Impact Assessment Handbook (2020): Provides the overall approach, definitions, and guidance for conducting PSIA.

Methodology Report Product Social Impact Assessment (2020): Details the underlying methodological choices, calculation rules, and assessment principles.

Social Topics Report (2022): Defines the relevant social topics, stakeholder categories, and performance indicators used in the assessment.

This chapter provides an overview of the key stages of the Product Social Impact Assessment (PSIA) methodology as defined by the Social Value Initiative and outlines how these stages will be applied within the ICARUS project. It also details the guiding principles that will underpin the assessments for each Demonstration Case.

5.1. Key Stages of the PSIA Methodology

The PSIA methodology, as detailed in the *Product Social Impact Assessment Handbook (2020)*, generally follows a life cycle assessment structure, adapted for social impacts. The main stages are:

5.1.1. Preparation Phase

Purpose: To understand the context of the assessment, define communication objectives, and prepare for data collection.

Key Activities:

Defining the communication context (e.g., internal decision-making, external reporting).

Conducting an initial **Materiality Assessment** to identify potentially relevant social topics and stakeholder groups. This is a crucial step to focus the assessment on the most significant issues.

Identifying and gaining access to appropriate data collection tools and sources.

ICARUS Application: This framework (D5.3) itself is a key output of the preparation phase for the project's SIA. The overall communication context is to support internal decision-making, fulfil project reporting, and potentially inform wider dissemination. The initial stakeholder identification (see Section 4.2.1) and subsequent materiality assessment (to be conducted via stakeholder surveys) are critical components of this phase for ICARUS.

5.1.2. Goal and Scope Definition

Purpose: To clearly define what is being assessed and why, and to establish the boundaries of the study.

Key Activities:

Defining the precise goal of the assessment for each specific product system (i.e., each Demo Case in ICARUS).

Describing the product system, its function, and defining the **Functional Unit (FU)** or **Declared Unit (DU)**.

Defining the **System Boundary** (e.g., cradle-to-gate, cradle-to-grave) (see Section 4.2.2 for general approach).

Establishing allocation rules and cut-off criteria (see Sections 4.2.3 and 4.2.4).

Reviewing and refining the initial materiality assessment based on the specific scope.

ICARUS Application: Chapters 6, 7, and 8 of this framework are dedicated to defining the specific goals, FUs/DUs, and system boundaries for each of the three ICARUS Demo Cases, incorporating the general principles outlined in this chapter.

5.1.3. Social Inventory Analysis (including Hotspot Identification)

Purpose: To collect data on the selected social topics and performance indicators for the processes within the system boundary.

Key Activities:

Hotspot Identification: A screening step to identify activities, locations, or suppliers within the value chain that are likely to have significant positive or negative social impacts. This helps prioritize data collection.

Data Collection: Gathering quantitative and qualitative data for the selected performance indicators. This involves using primary data (e.g., surveys, interviews with project partners, site-specific records) and secondary data (e.g., databases like SHDB or PSILCA, literature, NGO reports, national statistics).

Documenting data sources and assessing data quality (see Section 4.2.5).

ICARUS Application: Data collection will be a significant activity in the subsequent WPs (WP13, WP16) applying this framework. Hotspot identification will be performed for each Demo Case to focus efforts, guided by the material topics identified.

5.1.4. Social Impact Assessment

Purpose: To evaluate the collected inventory data against reference points to understand the level of social performance.

Key Activities:

Linking inventory data to performance indicators for each social topic.

Using the **5-point reference scales** (from -2 to +2) provided in the *Social Topics Report (2022)* to assess performance. This involves comparing the collected data against the descriptions for each level of the scale.

+2	best in class, continuous improvement
+1	beyond generally acceptable situation, continuous improvement
0	generally acceptable situation,
-1	unacceptable situation but improving
-2	unacceptable situation, no improvement

Figure 1 5-Point Reference Scales from the Social Topics Report (2022)

- Contextualizing the performance (e.g., considering country-specific risks, sector benchmarks).

ICARUS Application: This stage will be carried out for each Demo Case based on the data collected, using the reference scales from the PSIA methodology. The Demo Case specific sections (Chapters 6, 7, 8) will note any particular considerations for this stage.

5.1.5. Interpretation and Reporting

Purpose: To analyse the results, draw conclusions, identify limitations, and communicate the findings.

Key Activities:

Identifying key social hotspots (positive and negative impacts).

Analysing the contribution of different life cycle stages or activities.

Assessing uncertainty and sensitivity of results.

Drawing conclusions and making recommendations (if applicable).

Reporting the findings transparently, detailing the methodology, data, assumptions, and limitations.

ICARUS Application: The results for each Demo Case will be interpreted in the context of ICARUS goals. Reporting will primarily be internal to the consortium, with public dissemination following project guidelines (see Chapter 9).

5.2. Guiding Principles for ICARUS SIA

5.2.1. Stakeholders' engagement and materiality assessment

A robust Social Impact Assessment (SIA) hinges on correctly identifying and understanding the stakeholders potentially affected by the project. This section outlines how the ICARUS SIA framework leverages the PSIA methodology's stakeholder categories and integrates crucial inputs from WP3 (Dissemination and Communication) and WP4 (Exploitation Strategy and Business Models) for a comprehensive approach.

The PSIA methodology provides a set of general stakeholder categories that serve as a starting point for any social impact assessment. These include:

1. **Workers:** Individuals directly or indirectly employed along the product's value chain.
2. **Users/Consumers:** End-users of the products or services.
3. **Local Community:** People living or working in geographical proximity to project activities.
4. **Small-Scale Entrepreneurs:** Independent producers who may be part of the supply chain.

	Life-cycle stages				
Stakeholders addressed	Supply chain Raw material extraction, manufacturing, retail		Use	End of life	
	Small-scale entrepreneurs	Workers	Users[5]	Small-scale entrepreneurs	Workers
	Local communities				

Figure 2 General Stakeholder Categories and Life Cycle Stages Defined by the PSIA Methodology

These general categories provide a comprehensive lens to ensure all potential social interactions are considered. For the ICARUS project, these categories will be tailored and made specific for each Demonstration Case (see Chapters 6, 7, and 8).

While the PSIA methodology provides general stakeholder categories, their specific relevance and sub-categorization depend heavily on the context of the project and its individual demonstration cases.

The stakeholder mapping efforts undertaken in **WP3, specifically within Task 3.1 (Stakeholder Mapping)**, and the development of the **Stakeholder Engagement Model in WP4, Task 4.2**, provide foundational inputs for this framework. Moreover, in Task 5.3 and Task 5.4 additional stakeholders were mapped to better enhance the knowledge of the specific demo case landscape in relation to the PSIA categories.

The **Stakeholder Mapping (D3.1)**, an output of Task 3.1, identifies the key actors, groups, and organizations that have an interest in or may be affected by the ICARUS project and its demo cases. This mapping considers a broad range of stakeholders including industrial partners, recyclers, public authorities, research institutions, end-users in the construction sector, and civil society.

The **Stakeholder Engagement Model (D4.2)**, an output of Task 4.2, outlines strategies for interacting with these identified stakeholders. This model implicitly helps in understanding their potential concerns, interests, and the pathways through which they might be impacted by the project.

The **Stakeholder mapping in T5.3 and 5.4**, delivered through data collection by the partners involved in the development of each demo, resulted in the output of 3 spreadsheets documents with preliminary information on each demo specific stakeholder from the categories mentioned above in the PSIA methodology (workers, users and consumers, local communities and SMEs)

The insights from these WP3, WP4 and WP5 tasks are primary inputs for refining the general PSIA stakeholder categories into ICARUS-specific stakeholder groups and sub-groups for each Demo Case (detailed in Chapters 6.3, 7.3, and 8.3). This ensures that the social impact assessment focuses on those groups most likely to experience significant effects from the ICARUS innovations.

Beyond initial identification, the stakeholder understanding developed in WP3 and WP4 is vital for subsequent SIA activities within WP5, WP13, and WP16:

Materiality Assessment: The PSIA methodology includes a materiality assessment to prioritize the most relevant social topics for study. This assessment (planned for the next reporting period via stakeholder surveys) will directly utilize the stakeholder lists and engagement channels established by WP3 and WP4. The surveys will be targeted at these identified stakeholders to gather their perspectives on which social issues are most important in the context of each ICARUS demo case.

Co-creation and Data Collection: The co-creation and co-design approaches emphasized in the ICARUS proposal, and facilitated through WP3 and WP4, will provide qualitative data and perspectives. This information will enrich the social impact assessment, particularly regarding aspects like user acceptance of new materials, community impacts around demonstration sites, and the development of socially responsible products and business models. Ongoing stakeholder dialogue managed by WP3 and WP4 can also serve as a channel for gathering specific data needed for the SIA.

As the demo case are in a state of active development, a more in-depth mapping activities and ongoing monitoring in the second reporting period will be vital to identify the relevant stakeholders for each demo case and to assure that the materiality assessment of the social topics remain relevant.

Social topics for workers	Social topics for local communities
1.1 Occupational health and safety 1.2 Remuneration 1.3 Child labour 1.4 Forced labour 1.5 Discrimination 1.6 Freedom of association and collective bargaining 1.7 Work-life balance	3.1 Health and safety 3.2 Access to material and immaterial resources 3.3 Community engagement 3.4 Skill development 3.5 Contribution to economic development
Social topics for users	**Social topics for small-scale entrepreneurs**
2.1 Health and safety 2.2 Responsible communication 2.3 Privacy 2.4 Affordability 2.5 Accessability 2.6 Effectiveness and comfort	4.1 Meeting basic needs 4.2 Access to services and inputs 4.3 Women's empowerment 4.4 Child labour 4.5 Health and safety 4.6 Land rights 4.7 Fair trading relationships

5.2.2. General Approach to System Boundaries

The system boundary defines which life cycle stages and processes are included in the assessment. For the ICARUS project, the social impact analyses for each Demo Case will generally adopt a **"Cradle-to-gate with options"** approach. This means the assessment will typically cover:

Upstream processes: Sourcing of raw materials (both primary and the secondary resources targeted by ICARUS), transportation to processing/manufacturing sites.

Core processes: The ICARUS-specific upcycling and treatment processes, and the manufacturing of the intermediate SRM or final product.

Optional modules maybe included depending on the specific goals of the assessment for each Demo Case and data availability. These typically align with standard LCA modules:

Downstream processes: Further manufacturing using the ICARUS product, use phase of the final product.

End-of-Life (EoL) (Modules C1-C4):

- C1: Deconstruction/demolition.
- C2: Transport of waste.
- C3: Waste processing for reuse, recycling, or recovery.
- C4: Disposal.

Benefits and loads beyond the system boundary (Module D): This can include avoided burdens from recycling or reuse.

The specific system boundary for each Demo Case (detailed in Chapters 6.2, 7.2, and 8.2) will be aligned with the boundary defined for its corresponding Life Cycle Assessment (LCA) conducted in Task 5.2. This ensures consistency between environmental and social assessments. The selection of optional modules and any deviations will be clearly justified.

5.2.3. Allocation Rules

Allocation procedures will follow the guidelines in the PSIA Methodology Report. Where processes yield multiple co-products, allocation of social burdens will be avoided where possible by system expansion. If unavoidable, allocation based on physical relationships (e.g., mass, energy) or economic value will be applied and justified consistently across applicable Demo Cases.

5.2.4. Cut-off Criteria

Inputs/outputs may be excluded if they contribute less than 1% to the total mass, energy, or environmental significance **and** are demonstrated to have negligible social relevance based on the selected social topics for a given Demo Case. Cumulative cut-offs should not exceed 5%. Justification for any cut-offs will be documented. Particular attention will be paid to ensuring processes with known high social risks (even if small scale) are included in the assessment for each relevant Demo Case.

5.2.5. Data Quality Requirements

Data quality will be assessed consistently across all Demo Cases based on:

Source: Primary vs. Secondary.

Reliability: Verified, reported, estimated.

Temporal Correlation: Age of data.

Geographical Correlation: Location relevance.

Technological Correlation: Representativeness of the process/technology.

Efforts will be made to use the highest quality data available for each Demo Case, and data limitations and uncertainties will be documented in the respective assessment reports.

6. Demo Case 1: LAR Upcycling Assessment

This chapter outlines the specific application of the social impact assessment framework to Demo Case 1, focusing on the upcycling of Lithium Aluminosilicate Residue (LAR), for example, into ceramics or construction materials.

6.1. Goal of the Assessment (DC1)

To assess the social impact of new upcycling processes of lithium aluminosilicate residues (LAR) for the production of secondary raw materials (SRM) for the construction sector and their subsequent incorporation into these construction materials.

6.2. Functional Unit / Declared Unit (DC1)

To ensure consistency with the environmental assessment, the **Functional Unit (FU)** or **Declared Unit (DU)** for the Social Impact Assessment of DC1 **will be identical to the FU or DU defined for the corresponding Life Cycle Assessment (LCA)** (Task 5.2).

The FU/DU for DC1 will be approached in two stages, reflecting the different phases of material transformation and use:

Stage 1: Production of Secondary Raw Material (SRM)

DU (DC1 - SRM Production): 1 kg LAR treated according to the technical requirements for use as SRM.

Justification: This declared unit focuses the assessment on the core output of the initial upcycling process within DC1, allowing for evaluation of the social impacts directly associated with producing this intermediate SRM. It aligns with potential LCA units that quantify the treated material output.

Stage 2: Incorporation of SRM into Construction Materials Additional FUs/DUs will be declared for the assessment of the social impacts associated with the incorporation of the LAR-derived SRM into specific final construction materials. These will also be aligned with the respective LCAs. Examples include:

- Cement Production: 1 kg of cement
- Road Applications:
    - **Borrow material for embankments**: 1 kg of borrow material
    - **Stabilising agent for road base layers**: 1 kg of stabilising agent
    - **Asphalt mixtures (filler within bituminous mixtures)**: 1 kg of bituminous mixture
- Concrete Production: 1 m^3 of concrete
- Ceramic Tiles Production: 1 m^2 of ceramic tile

Justification for Stage 2 FUs/DUs: These units will focus on the performance and quantity of the final construction product, allowing for an assessment of social impacts related to the manufacturing and potential use phase of these specific applications.

6.3. System Boundary (DC1)

The system boundary for the DC1 social impact analysis will follow the general approach outlined in Section 4.2.2 ("Cradle-to-gate with options"), aligned with the LCA for DC1.

- Specific Core Processes for DC1 (SRM Production):
- Specific upcycling/treatment processes applied to LAR to produce the SRM.
- Transportation of treated LAR (SRM) to the point of use.
- Specific Optional Downstream/EoL/Module D Considerations for DC1.
- Manufacturing of specific construction materials (cement, road materials, concrete, ceramics) using the LAR-derived SRM.
- End-of-life management of LAR-containing construction products (Modules C1-C4).
- Benefits from recycling/reuse of LAR-based materials (Module D), e.g., avoided primary resource extraction.
- Processes Excluded (Justification).
- Capital goods, unless highly significant and specific social impacts are identified.
- General ICARUS R&D activities.

6.4. Stakeholder Subcategories (DC1)

Based on the overarching stakeholder categories in Section 4.2.1.1, the specific stakeholder subcategories and material social topics relevant to DC1 will be identified through a materiality assessment (informed by WP3/WP4/WP5 stakeholder mapping and subsequent surveys), considering severity, stakeholder concerns, project influence, legal context related to LAR handling, ceramics/construction sectors, and specific partner locations.

The general stakeholder subcategories identified in the first reporting period for DC1 are:

- I**ndustry and Commercial Stakeholders:** This is a primary group, encompassing the entire value chain. It includes **Lithium Mining and Processing Companies** (e.g., ICARUS partner Lithium Iberia - LI) as the generators of the LAR feedstock. Crucial are the **Technology Providers and Material Processors** (e.g., ICARUS partners K-UTEC, Université de Lorraine - UL, Instituto de Cerámica y Vidrio - ICV) who are developing the LAR treatment, purification, and upcycling technologies. Downstream, **End-User Industries** are vital, such as the **Ceramic Industry** (e.g., ICARUS partner KERABEN) for feldspar replacement, the **Cement and Concrete Industry** (including precast manufacturers and ready-mix companies) for SCMs or aggregates, and **Construction Companies and Road Authorities** (e.g., ICARUS partner ACCIONA) for road applications and hydraulic backfilling. This category also includes **Mining Companies** (other than LI) who might adopt LAR-based backfilling solutions, and **Equipment Manufacturers** for processing and application machinery.

- **Research and Academia:** This group, including ICARUS partners UL and ICV, as well as other universities and research centers, provides essential expertise in material science, geology, chemical engineering, civil engineering, and environmental science. They are key for R&D, independent testing, validation of LAR properties and applications, and developing innovative solutions.

- **Regulatory, Policy, and Standardization Bodies:** These stakeholders define the operational and market landscape. They include **National and EU Environmental Agencies** (responsible for waste classification, End-of-Waste criteria, environmental permits), **Mining Authorities** (regulating extraction and waste management at mine sites), **Construction and Material Standards Bodies** (e.g., CEN, national standardization organizations like AENOR in Spain) responsible for product safety, performance standards, and building codes. **Policymakers** at local, regional, national, and EU levels also shape the broader legislative context for circular economy and resource management.

- **Civil Society and Non-Governmental Organizations (NGOs):** This category includes **Environmental NGOs** who monitor the environmental impacts of mining, LAR processing, and the use of LAR-derived products. **Local Community Groups and Associations** near mining operations, LAR processing facilities, or significant construction sites using LAR products are critical for social license to operate. **Consumer Associations** may also take an interest in the safety and quality of end-products like ceramic tiles.

- **Financial and Investment Stakeholders: Investors, Banks, and Funding Agencies** (public and private) are crucial for financing the development, scaling-up of LAR processing technologies, and the commercialization of LAR-based products. Their perception of risk and return is a key factor.

- **Local and Regional Authorities:** Beyond specific regulatory roles, **Municipalities and Regional Governments** are key stakeholders in terms of land-use planning, local economic development (job creation), infrastructure development, and representing the interests of their constituents. They are often involved in permitting processes for new industrial facilities.

- **General Public and End Consumers:** While indirect, the **General Public's** perception of safety, sustainability, and the "waste-to-product" concept can influence market acceptance, especially for visible applications like ceramic tiles or public infrastructure. **End Consumers** of buildings or products incorporating LAR-materials are the ultimate arbiters of market success.

6.5. Assessment & Interpretation Notes (DC1)

The assessment will follow the PSIA methodology (Characterization, Scoring/Rating, careful Aggregation as detailed in section 4.1.4). Interpretation will focus on DC1 specifics.

Interpretation Focus: Identifying social hotspots (risks and opportunities) and benefits specific to the LAR upcycling value chain and its application in construction, informing DC1 development and responsible practices.

7. Demo Case 2: Cellulose Upcycling Assessment (from AHP and WWTP Residues)

This chapter outlines the specific application of the social impact assessment framework to Demo Case 2, focusing on the upcycling of cellulose-based secondary raw materials derived from Absorbent Hygiene Products (AHP) and Wastewater Treatment Plant (WWTP) residues, for example, into concrete slabs and pavements.

7.1. Goal of the Assessment (DC2)

To assess the social impact of new upcycling processes of cellulose fibres from AHP and WWTP residues for the production of SRM for the construction sector and their subsequent incorporation into concrete slabs and pavement production.

7.2. Functional Unit / Declared Unit (DC2)

To ensure consistency with the environmental assessment, the **Functional Unit (FU)** or **Declared Unit (DU)** for the Social Impact Assessment of DC2 **will be identical to the FU or DU defined for the corresponding Life Cycle Assessment (LCA)** (Task 5.2).

The FU/DU for DC2 will be approached in two stages:

Stage 1: Production of Secondary Raw Material (SRM)

- **DU (DC2 - SRM Production):** 1 kg high-quality Cellulose/SAP for use as SRM for slabs or pavements production.

Justification: This declared unit focuses on the social impacts associated with the production of the intermediate cellulose/SAP-based SRM from AHP and WWTP residues.

Stage 2: Incorporation of SRM into Construction Materials Additional FUs/DUs will be declared for the assessment of social impacts related to the incorporation of the SRM into final products. These will also align with respective LCAs. Examples include:

- **Concrete Slabs:** 1 m³ of concrete slabs.
- **Concrete Pavements:** 1 m³ of concrete pavements.
- **Prefabricated Concrete Slab/Pavement:** 1 unit of prefabricated concrete slab

Justification for Stage 2 FUs/DUs: These units allow for assessment of social impacts during the manufacturing and potential use of the final construction products.

7.3. System Boundary (DC2)

The system boundary for the DC2 social impact analysis will follow the general approach outlined in Section 4.2.2 ("Cradle-to-gate with options"), aligned with the LCA for DC2.

Specific Core Processes for DC2 (SRM Production):

- Collection and transport of AHP and WWTP residues.
- Pre-treatment of residues (e.g., sorting, shredding, sterilization if applicable).
- Cellulose extraction and processing to produce the SRM.
- Transportation of the cellulose-derived SRM to the point of use in construction material production.

Specific Optional Downstream/EoL/Module D Considerations for DC2:

- Manufacturing of concrete slabs and pavements incorporating the cellulose-derived SRM.
- End-of-life management of cellulose-containing concrete products (Modules C1-C4).
- Benefits from recycling/reuse (Module D), e.g., avoided primary aggregate production.

Processes Excluded (Justification):

- Capital goods, unless highly significant and specific social impacts are identified.
- General ICARUS R&D activities.

7.4. Stakeholder Subcategories (DC2)

Based on the overarching stakeholder categories in Section 4.2.1.1, the specific stakeholder subcategories and material social topics relevant to DC2 will be identified through a materiality assessment (informed by WP3/WP4/WP5 stakeholder mapping and subsequent surveys), considering severity, stakeholder concerns, project influence, legal context related to AHP/WWTP waste handling, cellulose processing, construction sector, and specific partner locations.

The general stakeholder subcategories identified in the first reporting period for DC2 are:

- **Waste Generators and Primary Sources:** This group includes Households and the General Public, who are the primary source of post-consumer AHP waste and indirectly contribute to the WWTP-derived cellulose found in municipal wastewater. Institutions such as hospitals, elderly care facilities, nurseries, and schools are also significant generators of AHP waste and crucial for targeted collection schemes. For WWTP-derived feedstock, Wastewater Treatment Plant Operators (e.g., ICARUS partner ACCIONA Agua) are responsible for the collection and initial recovery (e.g., via RBFs), although the cellulose itself originates primarily from the public.**Waste Management and Logistics Sector:**

Municipalities and Local Authorities play a vital role in defining urban waste management strategies, authorizing collection schemes, and potentially providing public infrastructure or support. **Private Waste Management and Wastewater treatment Companies** are key operational partners for the collection, transportation, sorting, and pre-processing of AHP waste and, potentially, for handling WWTP sludge.

- **Technology Providers and SRM Producers:** This category includes the developers and implementers of the core recycling technologies. For ICARUS, this involves **Technology Providers for AHP/WWTP Cellulose Recycling** (e.g., ICARUS partners IFOR, SMC Group) who are responsible for the sterilization, purification, and fiber recovery processes.

- **End-User Industries and Downstream Markets:** The primary target for the upcycled cellulose fibers is the **Construction Industry**, specifically **Concrete Producers** and **Construction Companies** (e.g., ICARUS partner ACCIONA) who would use the fibers as an additive in concrete formulations. Beyond this, the **Chemical Industry** represents a potential downstream market for valorizing cellulose or recovered SAP into products like carboxymethylcellulose (CMC) or other chemical intermediates.

- **Regulatory, Policy, and Standardization Bodies:** These entities shape the legal and normative framework. They include **National and EU Environmental Agencies** (for waste classification, End-of-Waste criteria, emissions from processing facilities), **Health Authorities** (critical for ensuring the safety of recycled materials from sensitive sources like AHPs and WWTP sludge), **Waste Management Authorities**, and **Construction Standards Bodies** (e.g., CEN, national bodies) responsible for approving new construction additives and updating relevant codes. **Policymakers** at all levels influence waste management policies and circular economy incentives.

- **Civil Society, and Research Community: AHP Manufacturers** are important as their product design choices (eco-design) significantly impact recyclability. **Retailers and Distributors of AHPs** can be key partners in collection schemes or public awareness campaigns. **Civil Society Organizations (CSOs), Environmental NGOs, and Health Advocacy Groups** will scrutinize the process for its environmental and public health implications. **Research Institutions and Academia** (e.g., ICARUS partner CAR) provide crucial technical expertise, independent testing and validation, Life Cycle Assessments (LCA), and contribute to innovation.

- **Economic and Financial Actors: Investors and Funding Agencies** are essential for financing the scaling-up of recycling facilities and the commercialization of the cellulose-based SRMs.

7.5. Assessment & Interpretation Notes (DC2)

The assessment will follow the PSIA methodology (Characterization, Scoring/Rating, careful Aggregation as detailed in Section 4.1.4). Interpretation will focus on DC2 specifics.

- **Interpretation Focus:** Identifying social hotspots (risks and opportunities) and benefits specific to the cellulose upcycling value chain (from AHP/WWTP residues) and its application in concrete products, informing DC2 development.

8. Demo Case 3: Steel Slags Upcycling Assessment

This chapter outlines the specific application of the social impact assessment framework to Demo Case 3, focusing on the upcycling of Steel Slags, for example, into construction materials, ceramics, and for internal recycling in steel facilities.

8.1. Goal of the Assessment (DC3)

To compare the Social impact of the conventional production of Precipitated Calcium Carbonate (PCC) versus the proposed process for steelmaking slags upgrading. The remaining slag utilization as SRM into construction, ceramics and recycling into steel facilities will be assessed. Depending on PCC quality obtained, its integration into different applications will be also considered.

8.2. Functional Unit / Declared Unit (DC3)

To ensure consistency with the environmental assessment, the **Functional Unit (FU)** or **Declared Unit (DU)** for the Social Impact Assessment of DC3 **will be identical to the FU or DU defined for the corresponding Life Cycle Assessment (LCA)** (Task 5.2).

The FU/DU for DC3 will be approached in stages, reflecting the different products and applications:

Stage 1: Production of Precipitated Calcium Carbonate (PCC) via Steel Slags Valorisation

- **DU (DC3 - PCC Production):** 1 kg of PCC produced from steelmaking slags.
- FU **(DC3 - PCC Production): 1kg of treated slag**

Justification: This declared unit focuses on the social impacts associated with the innovative PCC production route. It allows for comparison with conventional PCC production if a baseline is established.

Stage 2: Incorporation/Utilization of PCC and Remaining Slag Additional FUs/DUs will be declared for the assessment of social impacts related to the valorisation of PCC and the remaining slag in various applications. These will also align with respective LCAs. Examples include:

- Construction Applications (using remaining slag): FU: 1m^3 o 1kg of concrete /asphalt
- Ceramics (using remaining slag): 1 m2 of ceramic tiles.
- Internal Recycling (Steel Facilities - using remaining slag): 1 kg of sinter.
- PCC market (to be defined depending of the PCC characteritics).

Justification for Stage 2 FUs/DUs: These units allow for assessment of social impacts during the manufacturing and potential use/recycling of the final products or intermediate materials derived from the steel slag valorisation process.

8.3. System Boundary (DC3)

The system boundary for the DC3 social impact analysis will follow the general approach outlined in Section 4.2.2 ("Cradle-to-gate with options"), aligned with the LCA for DC3.

Specific Core Processes for DC3 (Innovative PCC & Slag Valorisation):

- Sourcing and transport of steel slags from steelmaking facilities.
- Pre-treatment of steel slags.
- PCC production process using steel slags.
- Processing of remaining slag for its various applications.
- Transportation of PCC and treated slag to points of use.

Specific Core Processes for Comparative System (Conventional PCC):

- Sourcing and transport of limestone.
- Calcination, slaking, and carbonation for conventional PCC production.
- Transportation of conventional PCC.

Specific Optional Downstream/EoL/Module D Considerations for DC3:

- Manufacturing of construction products (concrete, asphalt), ceramics, or sinter using PCC/treated slag.
- End-of-life management of products containing slag/PCC (Modules C1-C4).
- Benefits from recycling/reuse (Module D).

Processes Excluded (Justification):

- Capital goods, unless highly significant and specific social impacts are identified.
- General ICARUS R&D activities.

8.4. Stakeholder Subcategories (DC3)

Based on the overarching stakeholder categories in Section 4.2.1.1, the specific stakeholder subcategories and material social topics relevant to DC3 will be identified through a materiality assessment (informed by WP3/WP4/WP5 stakeholder mapping and subsequent surveys), considering severity, stakeholder concerns, project influence, legal context related to steel slag handling, PCC production, construction/ceramics/steel sectors, and specific partner locations.

The general stakeholder subcategories identified in the first reporting period for DC3 are:

- **Primary Industrial Actors:** This core group includes the **Steel Industry** (e.g., ICARUS partners ArcelorMittal - AMI3, AME, AMMR) as the generators of BOF and EAF slags and potential internal users of treated slag. **Technology Providers and Material Processors** (e.g., ICARUS partner CALES DE LLIERCA) are central to developing and implementing the slag treatment, carbonation, and PCC production technologies.

- **End-User Industries for Slag-Derived Products:**

  - **Construction Sector:** This includes **Construction Companies** (e.g., ICARUS partner ACCIONA) and **Concrete Producers** who are potential users of stabilized slag as an aggregate or filler replacement. Other entities include **Cement Manufacturers** (for blended cements), **Road Construction Companies**, and **Manufacturers of Construction Products** (e.g., blocks, pavers).

  - **Ceramic Industry:** (e.g., ICARUS partner KERABEN and research partner CSIC-ICV) are potential end-users of stabilized slags as pigments or raw material components in tiles and other ceramic bodies.

  - **PCC Consumers:** A diverse group including industries such as **Paper (as filler/coating), Plastics (as filler), Paints & Coatings (as extender/filler), Adhesives & Sealants, and potentially Food/Pharma** (requiring very high purity, which may be a challenge for slag-derived PCC). This group also includes **Manufacturers of Construction Materials** that use PCC (e.g., in mortars, plasters, asphalt).

  - **Steel Industry (Internal Use):** As mentioned, ArcelorMittal itself is an end-user for internal valorization of coarser slag fractions, potentially as a flux or raw material substitute in the steelmaking process.

- **CO_2 and Energy Value Chain: CO_2 Emitters/Suppliers** are critical if CO_2 is not solely sourced from the steel plant's flue gases; this could include other nearby industrial emitters (e.g., cement plants, power plants, refineries). **CO_2 Transportation and Logistics Providers** may also be involved. **Energy Providers** are relevant due to the energy demands of the carbonation process, with a preference for renewable energy sources to enhance sustainability.

- **Regulatory, Policy, and Standardization Bodies:** This group includes **National and EU Environmental Agencies** (regulating slag management, emissions, EoW criteria for treated slags and PCC), **Industrial Emissions Authorities** (governing CO_2 capture and industrial processes), **Climate Policy Bodies** (relevant for CCSU frameworks and CO_2 accounting, carbon pricing/ETS), and **Construction, Ceramic, and Chemical Standards Bodies** (e.g., CEN, ISO, national bodies like AENOR) responsible for product standards, safety, and performance criteria. **Policymakers** at all levels influence frameworks for CCSU, circular economy, industrial decarbonization, and green public procurement.

- **Civil Society, Local Communities, and NGOs: Local Communities** residing near steel plants or potential new slag processing/carbonation facilities are key stakeholders concerned with environmental impacts (dust, noise, traffic, land use, water quality) and socio-economic effects (jobs, local economy). **Environmental NGOs and Climate Action Groups** will scrutinize the CCSU aspects, the overall carbon footprint, the "permanence" of CO_2 storage in mineralized form, and the sustainability claims of the process. **Trade Unions and Worker Representatives** will be interested in occupational health and safety and job quality.

- **Research, Academia, and Technical Experts: Research Institutions** (e.g., ICARUS partner CARTIF, CSIC-ICV) and universities provide expertise in carbonation chemistry, material science, process engineering, LCA, socio-economic assessment, geology (for CO_2 sourcing if applicable), and public perception studies. **Technical Consultants and Engineering Firms** may also be involved in plant design, implementation, and safety assessments.

- **Financial and Market Actors: Investors, Banks, and Funding Agencies** are vital for financing the development and deployment of the technology. **Carbon Market Actors** (e.g., traders, verifiers) could become relevant if carbon credits or specific CO_2 pricing mechanisms are part of the business model. **Industry Associations** (e.g., steel, cement, chemical, construction, PCC producers) play a role in disseminating information, shaping industry perspectives, and advocating for supportive policies.

8.5. Assessment & Interpretation Notes (DC3)

The assessment will follow the PSIA methodology (Characterization, Scoring/Rating, careful Aggregation as detailed in Section 4.1.4). Interpretation will focus on DC3 specifics, including comparative aspects if conventional PCC is a baseline.

- **Interpretation Focus:** Identifying social hotspots (risks and opportunities) and benefits specific to the steel slag valorisation pathways, comparing with conventional methods where applicable, and informing DC3 development for enhanced social performance.

9. Reporting and Communication

The findings of the PSIA conducted under this framework for each Demo Case will be reported internally to the ICARUS consortium to inform decision-making, in D13.3, D16.3 and D16.4.

D13.3 will include the materiality assessment and primary and secondary data sources that will be intended to use in the social impact assessment. If needed by the specific demo assessment goal and scope, D13.3 will include a baseline assessment to be compared with the final social impact assessment.

D16.3 will include the final social impact assessment for each demo case, if needed by specific demo goal and scope the deliverable will include a comparative analysis between the baseline scenario outlined in D13.3 and the demo scenario.

D16.4 will combine the final social impact assessment consideration and results with the E-LCA and LCC analysis results to outline a comprehensive sustainability assessment for each demo case.

Public reporting or communication will follow project guidelines and the communication rules outlined in the PSIA Handbook (e.g., transparency about scope, methodology, limitations). Reports will clearly document the goal and scope, methodology, data sources, results (disaggregated by topic/stakeholder), limitations, and interpretation for each assessed Demo Case.

10. References

Goedkoop, M.J.; de Beer, I.M; Harmens, R.; et al. (2020). *Product Social Impact Assessment Handbook - 2020*. Roundtable for Product Social Metrics. Amersfoort.

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