RIECS
concept

Deliverable 4.4: Global Policy Organisations Report

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Acronym	Open form
RIECS	European Research Infrastructure for Excellence in Citizen Science
WP	Work Package
CS	Citizen Science
SDG	Sustainable Development Goals
UN	United Nations
IO	International Organizations
CERN	European Organization for Nuclear Research
OS	Open Science
OScH	Open Science Hardware
UNEA-7	7th United Nations Environment Assembly
CSGP	Citizen Science Global Partnership
MEA	Multilateral Environmental Agreement
UNEP	United Nations Environment Programme
UN ESCAP	United Nationals Economic and Social Commission for Asia and the Pacific
UN DESA	United Nations Department of Economic and Social Affairs
UNITAR	United Nations Institute for Training and Research
UNSPBF	UN Science-Policy-Business Forum on the Environment
APPEC	Astroparticle Physics European Consortium
TTO	Technology Transfer Office
OSPO	Open Source Program Office

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Executive Summary

This deliverable reports on the engagement carried out under Task 4.4 "*Integration with policy-making organisations"* with "global policy organisations and international research institutions" (target group TG10 of the proposal) during the first 18 months of RIECS-Concept.

While RIECS is being conceptualised as a European Research Infrastructure, the challenges addressed by Citizen Science (e.g. climate change, biodiversity loss, environmental monitoring, and more) are inherently global. The infrastructure therefore seeks to position itself not only as a service provider for European communities, but also as a trusted partner within international science, policy, and innovation ecosystems, contributing to global knowledge exchange, interoperability, and collaboration.

Engagement with stakeholders is based on dedicated and carefully tailored approaches that recognize their role at the intersection of global policy, international coordination, and monitoring of sustainable development. Unlike many other stakeholder groups, international organizations work across countries, cultures, and governance systems, and therefore require approaches that facilitate knowledge-sharing, coordination, and trust-building at a global level. Their involvement is considered essential to ensure that the future RIECS infrastructure aligns with international policy frameworks and supports wider uptake of CS for the SDGs .

Activities reported here include five complementary engagement streams, including three primary policy engagement streams (1-3) and two implementation and validation activities (4-5):

1. A session at the 4th UN Expert Group Meeting on Citizen Data, which generated requirements from National Statistical Offices and UN bodies.
2. Coordinated participation in UNEA-7, including advocacy, convening, and programme-development efforts.
3. Two interviews with key informants from UN agencies.
4. The Astroparticle Physics European Consortium (APPEC) Strategy 2027–2036 Open Science & Citizen Science Working Group, a powerful use case aimed at embedding RIECS-relevant recommendations in the next European astroparticle-physics roadmap.
5. The HEROES workshop on Open Science Hardware, bringing together international leaders sharpen the requirements for the instrumentation and tooling layer of RIECS.

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Taken together, these activities allow the consortium to translate the abstract requirements of global policy organisations and international research institutions into a concrete and converging set of requirements for the design of RIECS. The following priorities emerge consistently across all five streams:

1. **A connective layer, not another platform**
   International stakeholders ask RIECS to make existing data, tools and communities visible, discoverable, interoperable and usable for policy. This positions it as a connective infrastructure on top of an already mature but fragmented ecosystem.

2. **Interoperability with global frameworks**
   Requirements are anchored in global instruments that already exist, e.g. the Copenhagen Framework on Citizen Data, the UNESCO Recommendation on Open Science, FAIR/CARE principles, the SDG indicator system and Multilateral Environmental Agreements.

3. **Citizen Science as a legitimate research methodology**
   Across UN and large research-infrastructure settings, partners ask RIECS to help reposition CS from “outreach” to a recognised methodology, with the curation, standardisation, governance and evaluation that this implies.

4. **Open Science Hardware as part of the infrastructure stack**
   International organisations, research infrastructures and procurement bodies converge on the view that low-cost, openly documented and locally maintainable instruments are a structural component of a global CS ecosystem, particularly for inclusion of underserved regions and for technological sovereignty.

5. **Policy-ready outputs and stable institutional homes**
   Beyond datasets, stakeholders need decision-ready outputs (dashboards, indicators, briefs), expert mechanisms and governance arrangements that survive individual project cycles. Long-term sustainability is repeatedly raised as a precondition for engagement.

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1.Introduction

RIECS-Concept aims to design a pan-European Research Infrastructure for Excellent Citizen Science. Achieving this requires going beyond the European boundary: many of the scientific challenges that CS addresses (e.g. biodiversity loss, climate change, environmental observation, public health, sustainable-development monitoring) are intrinsically global, and the data, methodologies and policy frameworks involved sit within a global architecture led by the UN system, by international organisations (UNEP, UNESCO, ITU, etc.) and by major international research infrastructures and networks (CERN, APPEC and others).

This deliverable documents the engagement carried out under Task 4.4 with target group TG10 — international organisations and global policy-making institutions — during the first 18 months of the project, complemented by the international dimension of TG9 (large research infrastructures). It reports five engagement streams: a session at the 4th UN Expert Group Meeting on Citizen Data; coordinated participation in UNEA-7; the APPEC Strategy 2027–2036 Open Science & Citizen Science Working Group; the HEROES workshop on Open Science Hardware; and a series of structured interviews with key informants from UN agencies and international organisations. The findings feed directly into the requirements catalogue (KER 1), the conceptual design (KER 2 and KER 3), and the sustainability roadmap (WP3), and complement the requirements gathered from citizens (T4.2) and from researchers, networks and other stakeholders (T4.3).

Methodology

Rationale for the Engagement Structure

The activities reported in this deliverable can be grouped into two complementary categories: 1) policy engagement activities and 2) implementation and validation activities.

1) The policy engagement activities (UNEA-7, the Citizen Data Workshop, and the interviews) were designed to identify expectations, priorities, and requirements emerging from international governance, sustainable-development, and science-policy contexts. These activities provided insights into how CS can contribute to official statistics, environmental governance, multilateral processes, and evidence-informed decision-making.
2) The implementation and validation activities (APPEC and HEROES) examined these requirements from the perspective of operational scientific and technological communities. They provided an opportunity to assess whether the needs expressed by policy actors are compatible with existing research infrastructures, open science practices, scientific workflows, and emerging technological ecosystems. They also helped identify the technical, organisational, and governance conditions required to translate policy expectations into viable infrastructure services.

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Engagement modalities

Three engagement modalities were combined:

1. Co-organised workshops at events that international stakeholders were already attending or convening (UNDESA Expert Group Meeting; HEROES; UNEA-7 Green Room; APPEC strategy meetings). This minimised additional burden on policy actors and maximised the legitimacy of the discussion within their own institutional cycles.
2. Embedded participation in policy and strategy processes (most visibly the APPEC Strategy 2027–2036 Working Group and the negotiation of UNEA-7 draft resolutions) where requirements for RIECS could be formulated in the language and through the instruments used by these actors.
3. Structured key-informant interviews with senior officers (UNITAR, UNSPBF) used to triangulate findings from the workshops and to capture institutional context that does not emerge in plenary settings.

Each activity contributes either specific user stories or recommendations and policy uptake that feed directly into the requirements catalogue (KER 1) and the conceptual design (KER 2 and KER 3) of RIECS.

Relevance for RIECS

International stakeholders approach RIECS as a candidate interface between three policy and knowledge spaces that today operate in parallel: (i) the European citizen-science ecosystem; (ii) the global statistical and environmental-governance system anchored in the UN; and (iii) the open-science / open-hardware movement that increasingly underpins distributed scientific practice. Each engagement reported in Chapter 6 of this deliverable corresponds to a different point in this interface:

- engagement with UNDESA, the Collaborative on Citizen Data, UN ESCAP and UNITAR clarifies the requirements for connecting citizen-generated data to official statistics and SDG monitoring;
- engagement around UNEA-7, UNEP, the Convention on Biological Diversity and the Major Groups system clarifies the requirements for connecting CS to Multilateral Environmental Agreements and global environmental governance;
- engagement with the APPEC Open Science & Citizen Science Working Group, CERN and the UN Science-Policy-Business Forum clarifies the requirements for connecting CS to large research infrastructures and to the global science-policy-business interface;
- engagement around HEROES / Open Science Hardware with UNESCO, ITU, CERN, foundations and OSPOs clarifies the requirements for the instrumentation and tooling layer of a globally usable CS infrastructure.

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International policy frameworks

RIECS-concept seeks to align with established international and global policy, research, and governance frameworks relevant to CS, OS, sustainable development, and research infrastructures. The following table highlights the principal frameworks that provide the policy context for the activities reported in this deliverable and against which the emerging requirements for RIECS should be anchored.

Table 1 Relevant International and global policy frameworks

Framework	Relevance for RIECS
UN 2030 Agenda for Sustainable Development	Primary global framework connecting CS and citizen-generated data to sustainable development monitoring and policy making.
Global SDG Indicator Framework	Defines official SDG indicators to which citizen-generated data may contribute.
Copenhagen Framework on Citizen Data	Most directly relevant framework for integrating citizen-generated data into national and global data ecosystems.
UNESCO Recommendation on Open Science (2021)	Global normative framework for open knowledge, open infrastructures, citizen science, and equitable participation in science.
FAIR / CARE	International standard for making data Findable, Accessible, Interoperable and Reusable. CARE complements FAIR by addressing rights, governance, and benefits associated with community and Indigenous data.
Convention on Biological Diversity (CBD)	Major environmental governance framework increasingly incorporating CS contributions.
Kunming–Montreal Global Biodiversity Framework	Global biodiversity targets whose monitoring can benefit from citizen science data.
Paris Agreement (UNFCCC)	Relevant for climate-related citizen observations and community monitoring.
Sendai Framework for Disaster Risk Reduction 2015–2030	Supports community-based monitoring, resilience, and disaster-risk information systems.
UN Declaration on the Rights of Indigenous Peoples (UNDRIP)	Relevant where citizen science involves Indigenous knowledge systems and governance of associated data.

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OECD Very Large Research Infrastructures: Policy Issues and Options (2023)	Guidance on the governance, sustainability, societal value, interoperability and policy relevance of large-scale research infrastructures.

Structure of the Deliverable

The remainder of D4.4 is organised as follows. Chapter 6 reports each engagement activity in detail, with contextual background, format, participants, goals and findings. Chapter 7 (High-level synthesis) consolidates the requirements emerging from these activities into a coherent set of design implications for RIECS. In includes requirements clustered by function and by stakeholder type; cross-cutting issues that span all activities and that should be addressed transversally; policy contributions of each activity; and analysis of criticalities and potential tensions. Chapter 8 summarizes the specific requirements that emerged in the engagement activities. Chapter 9 draws initial conclusions and reminds the next steps for WP2, WP3 and WP5. Appendixes integrate the information as follows: Appendix A provides the detailed list of HEROES participants and the user-story matrix; Appendix B shows the draft APPEC recommendations on Open Science and Citizen Science; Appendix C lists existing science-policy and science-policy-society interfaces relevant to RIECS.

2. Activities

Table 2 provides an overview of the engagement activities carried out with International organisations and global policy-making institutions to support the co-design of RIECS. Each activity is described in more detail in the following sections.

Table 2 Overview of the engagement activities

Date	Activity	Organized by	Main Organizations involved
Nov 2025	"RIECS-Concept" workshop at the "4th Expert Group Meeting on Citizen Data and Workshops"	CSGP	*(Primary policy engagement)* United Nations Department of Economic and Social Affairs (UNDESA), Collaborative on Citizen Data, United Nations Economic and Social Commission for Asia and the Pacific (UN ESCAP)
Dec 2025	UNEA7 Preparations and Participation (Multiple Activities)	CSZ / CSGP	*(Primary policy engagement)*

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			UNEP, Convention on Biological Diversity (CBD), UN Major Groups and other Stakeholders (MGoS)
Mar-Apr 2026	Interviews	CSZ	*(Primary policy engagement)* UNITAR, UN Science-Policy-Business Forum on the Environment (UNSPBF)
Jan – Sep 2025	APPEC Strategy 2027-2036: Open Science & Citizen Science Working Group	CSZ	*(Validation case)* APPEC (consortium of funding agencies, national government institutions, and institutes from 18 European countries)
Jan 2026	HEROES Workshop: Advancing Open Science Hardware Ecosystems	CSZ / CSGP	*(Validation case)* CERN, Open Science Hardware Foundation

2.1. RIECS-Concept Workshop at "4th Expert Group Meeting on Citizen Data and Workshops"

2.1.1. Contextual Background

There is a growing recognition that data and knowledge production should be more inclusive, participatory, and responsive to societal needs (OECD, 2023; Kondo, 2019; Ahrweiler et al., 2024). While emerging from different traditions and serving diverse purposes, approaches such as CS, citizen-generated data, and community-based monitoring are increasingly converging toward more collaborative and equitable models of data collection. These approaches emphasize meaningful stakeholder engagement, transparency, and the importance of ensuring that communities are not only contributors but also beneficiaries of the data they help generate. At the same time, they highlight the need to better connect local data efforts with global monitoring frameworks, such as the SDGs, and to strengthen the role of citizen data in informing policy and decision-making.

In March 2025, the 56th session of the United Nations Statistical Commission endorsed the Copenhagen Framework on Citizen Data. This was a major milestone, marking global recognition of citizen data as a key resource within the national data ecosystem and highlighting the Framework's importance as a guiding tool for countries to sustainably

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produce and use citizen data for more inclusive, participatory, and policy relevant data systems and decision making.

The Framework was produced by the Collaborative on Citizen Data, established in April 2023 by the United Nations Statistics Division and other partners. The Collaborative brings together international, national and local actors to support more strategic, coordinated and inclusive efforts around citizen data, aiming to bridge data production with policy use and impact and ensure that diverse perspectives inform decision-making at all levels.

2.1.2. Overview

Activity: "RIECS-Concept" session at the 4th Expert Group Meeting on Citizen Data and Workshops

Date: 10 November 2025

Location: Bangkok, Thailand

Hosted by: The United Nations Department of Economic and Social Affairs (UNDESA), in collaboration with the Collaborative on Citizen Data and the United Nations Economic and Social Commission for Asia and the Pacific (UN ESCAP)

Organised by: CSGP

Participants: The workshop brought together around 40 participants, primarily national and global-level policymakers, including representatives from National Statistical Offices (NSO), government agencies, and UN bodies, alongside CS data producers from academia and civil society.

Format: The format combined a short presentation on the RIECS framework and use case methodology ("user stories") with facilitated breakout group discussions, during which participants collaboratively developed user stories reflecting their perspectives and institutional needs. Participants were strongly engaged, particularly during in-depth discussions in smaller groups, and the session generated 16 user stories.

Goal: The session aimed at introducing the RIECS concept and engaging relevant stakeholders in a co-design process to identify needs and use cases for integrating CS data into official statistical systems .

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Figure 1. Launch of Citizen Science Working Group the 4th UN Expert Group Meeting on Citizen Data in Bangkok

2.1.3. Summary of Findings

Note that, as this session involved both national and global policy actors alongside citizen data producers, the workshop is also reported in Deliverable D4.3. While the present deliverable focuses specifically on outcomes related to representatives from the UN and other international organizations, Deliverable D4.3 provides a comprehensive account of the workshop results. This is because the event primarily targeted policy actors who attended the event, and that deliverable is dedicated to documenting engagement with policymakers at both the national and global levels, including the National Statistical Offices and the UN. A review of the user stories generated in the workshop indicates that, although many of them originate from National Statistical Offices (NSOs), there are also clear inputs from UN actors, international organizations, civil society, and academia, reflecting a broader set of shared needs across the data ecosystem.

A first common priority is addressing persistent data gaps, particularly for marginalized and hard-to-reach populations such as people with disabilities or informal communities. International actors emphasized the importance of more inclusive and disaggregated data to support policy and humanitarian action. Closely linked to this is the need for better integration of data systems, including infrastructures that enable the combination of citizen-generated data with official and other data sources, ensuring validation, updating,

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and scalability over time . This includes a demand for platforms, standards, and frameworks that facilitate data sharing and collaboration across institutional boundaries.

At the same time, concerns around data quality, trust, and standardization remain central barriers to uptake, particularly regarding reliability, comparability, and governance of citizen-generated data . These challenges are compounded by capacity constraints, as many institutions lack the technical skills, resources, or incentives to effectively engage with new data approaches .

Overall, the user stories point to a strong need for enhanced collaboration across public institutions, international organizations, and civil society, with citizen-generated data seen as a valuable complement to official statistics in strengthening evidence-based policymaking.

2.2. UNEA7 Preparations and Participation (Multiple Activities)

2.2.1. Contextual Background

UNEA-7 is the seventh session of the United Nations Environment Assembly, the world's highest-level decision-making body on environmental matters, convened by the United Nations Environment Programme (UNEP). Bringing together UN Member States, international organisations, scientists, civil society, and other stakeholders, UNEA provides a global platform for shaping environmental policy and advancing collective action on major sustainability challenges. The thematic areas addressed during UNEA-7, such as environmental observation, climate change, and public health, align closely with the domains selected in RIECS as priority fields for examining CS practices and infrastructure needs, and where improved coordination, interoperability, and shared infrastructure could significantly enhance effectiveness.

On behalf of RIECS, CSZ contributed to the planning and coordination of the activities of CSGP representatives at UNEA-7, where CSGP undertook coordinated advocacy, convening, and programme-development efforts. The activities provided valuable policy engagement, stakeholder connections, and practical insights to support the strategic objectives of RIECS.

2.2.2. Overview

Title: Different activities at the United Nations Environment Assembly (UNEA-7)

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Date: 8-12 Dec 2025

Location: UNEP Headquarters, Nairobi, Kenya

Organised by: CSGP and CSZ in collaboration with Science & Technology Major Group partners and collaborators.

Participants: Delegates attending UNEA-7, including representatives from UNEP Science Division, Convention on Biological Diversity (CBD), UN Major Groups and Stakeholders, CS associations and networks, NGOs and civil society organisations.

Goal: The activities had two key goals:

- to demonstrate how CS can support environmental governance and the implementation of global environmental agreements, while strengthening international collaboration and advancing global citizen science initiatives
- to highlight the growing need for coordinated research infrastructures, interoperable data systems, stakeholder networks, and science-policy interfaces capable of supporting citizen science at regional and global scales.

Figure 2. Some of the CS delegates at UNEA7

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2.2.3. Activity 1: Strategic Advocacy - Embedding CS in UNEA Resolutions

At UNEA-7, CSGP coordinated a targeted advocacy effort to strengthen recognition of CS within international environmental policy processes. A global delegation of 28 CS practitioners and experts was mobilised to engage with the Assembly through the Science and Technology Major Group and the NGO Major Group, ensuring that CS perspectives were represented within UNEA's stakeholder engagement structures. The engagement started online long before the event and continued in person during the event.

A central focus of the delegation's work was involvement in the negotiations of UNEA draft resolutions. CSGP representatives acted as Draft Resolution Contact Points for two key proposals: the Japanese resolution on scaling up synergies in the implementation of Multilateral Environmental Agreements (MEAs) at national and local levels, and the Swiss resolution addressing chemicals and waste. In these roles, the delegation monitored negotiations and submitted a proposal aimed at integrating CS into the implementation frameworks of MEAs.

The delegation also proposed mechanisms to strengthen coordination and knowledge sharing across countries, including the potential creation of a UN-level expert mechanism on CS and MEAs. Delegates complemented these formal contributions by engaging directly with national delegations and permanent representatives in Nairobi. As a result of these efforts, CS was introduced into discussions related to MEA implementation and referenced in statements delivered by the Science and Technology Major Group.

Overall, the advocacy undertaken at UNEA-7 helped shift CS from a peripheral concept to a more structured policy proposal within the UNEA process, laying the groundwork for further integration of CS into global environmental governance in the lead-up to future sessions of the Assembly.

2.2.4. Activity 2: High-Level Convening and Visibility - The Green Room Event

CSGP organised a high-level "Green Room" event entitled People and Policy Together: Building Global CS for a Resilient Planet. The event provided an important platform within the UNEA programme to present the role of CS and RIECS in supporting the implementation of global environmental policy.

The session focused on demonstrating how CS can contribute to the implementation of MEAs by expanding environmental monitoring, improving data availability, and strengthening public engagement in environmental action. It brought together

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representatives from UNEP, multilateral environmental agreements, and the UN Major Groups system, alongside leading figures from the global CS community. Speakers included the UNEP Chief Scientist, representatives of the Convention on Biological Diversity (CBD), and leaders from the Science and Technology and Children and Youth Major Groups. The event was organised as a hybrid session, allowing both in-person participation at the UNEP headquarters in Nairobi and online participation from the global CS community.

Overall, the Green Room event:

- helped raise awareness of the scale and maturity of CS initiatives globally, significantly increasing the visibility of CS within the UNEA process
- highlighted the Charter on CS and MEAs, which sets out a framework for integrating CS into international environmental governance.
- reinforced the importance of partnerships between CS networks, research institutions, governments, and international organisations in advancing environmental action.
- Strengthened relationships with UNEP's Science Division and other international partners, creating a strong foundation for future collaboration between the CS community and global environmental governance processes. These connections also contribute to the development of the international stakeholder networks needed for the successful development and adoption of RIECS.

Figure 3 Green Room Event at UNEA7

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2.2.5. Activity 3: Programme Development - Advancing Global CS Initiatives

UNEA-7 was also used as an opportunity to advance the development of global CS programmes addressing key environmental challenges. During the Assembly, the CSGP delegation presented plans for two emerging global initiatives focused on climate change mitigation and air quality and health. The Climate Change Mitigation Initiative aims to engage citizens in monitoring and reducing emissions-related activities while contributing data that can inform climate policy and behavioural change strategies. The Air Quality and Health programme seeks to expand community-based monitoring of air pollution, helping to fill gaps in official monitoring networks while raising awareness of the health impacts of poor air quality. At UNEA-7, elements of these initiatives were demonstrated by CS delegates through practical examples, including wearable air quality monitoring devices.

Both programmes build on existing successful CS models, particularly the Global Mosquito Alert consortium, which demonstrates how coordinated citizen participation can generate large-scale environmental datasets for environmental policy. They represent strategic use cases for RIECS, providing practical insights into the types of technical services, data standards, and coordination mechanisms that RIECS should provide.

Indeed, their success depends on addressing key challenges that RIECS is designed to tackle, including data interoperability, methodological harmonisation, long-term data stewardship, and the integration of citizen-generated data into research and policy processes.

2.3. Interviews

2.3.1. UNITAR

2.3.1.1. Contextual Background

The United Nations Institute for Training and Research (UNITAR), an autonomous UN body established in 1963, is a dedicated training arm of the UN system and has the mandate to enhance the effectiveness of the UN through diplomatic training, and to increase the impact of national actions through public awareness-raising, education and training of public policy officials. UNITAR provides training and capacity development activities to assist mainly developing countries and groups and communities who are most vulnerable, including those in conflict situations.

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Its work spans key areas such as peacebuilding, social inclusion, environmental protection and climate action, and sustainable economic growth, alongside efforts to foster knowledge-sharing and support the implementation of the 2030 Agenda. It also conducts research on innovative learning approaches, methods, and tools, as well as applied research to address critical issues, such as disaster risk reduction and humanitarian emergencies.

2.3.1.2. Overview

Activity: Interview with Madina Imaralieva. Madina is an Associate Programme Officer at UNITAR. She specializes in designing training programs related to official statistics, the SDGs, and systems thinking, often contributing to the UN SDG:Learn platform. Madina has been involved in EU Crowd4SDG and in the writing and submission of several EU grant proposals on the topic of CS.

Organised by: CSZ

Goal: Medina (and her former Head of Unit Elena Proden, Senior Specialist, Strategic Implementation of the 2030 Agenda Unit at UNITAR) has a vast experience with working on the integration of CS data - and in general citizen-generated data – with official NSO data. The goal of the interview was to gather specific info about core needs of UN and international organization stakeholders (via UNITAR/NSOs).

2.3.2. UN Science-Policy-Business Forum on the Environment (UNSPBF)

2.3.2.1. Contextual Background

UNSPBF was established by UNEP in 2017 to strengthen collaboration between the scientific community, policy-makers, businesses, and civil society in addressing global environmental challenges. The Forum aims to accelerate the uptake of scientific knowledge into decision-making processes and to identify innovative approaches for implementing environmental and sustainable-development goals.

Given its focus, UNSPBF provides a valuable perspective on the potential role of CS within international governance processes and on the requirements needed for citizen-generated evidence to inform policy-making at regional and global scales.

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2.3.2.2. Overview

Activity: A semi-structured interview was conducted with Shereen Zorba, Executive Secretary of UNSPBF and Chief, Science-Policy-Business Interface and Knowledge Networks at UNEP.

Organised by: CSZ

Goal: The objective of the interview was to explore perspectives on the potential role of CS infrastructures, the challenges of integrating citizen-generated knowledge into policy processes, and the strategic considerations relevant to the development of RIECS. In the past Ms. Zorba contributed to several efforts to coordinate fragmented communities and projects in CS (e.g. the establishment of CSGP) and she can provide invaluable insights and governance considerations for future infrastructures, including challenges related to trust and verification of citizen-generated data, and the broader geopolitical and institutional context.

2.3.2.3. Summary of findings

Beyond domain-specific observations, interviewees highlighted a number of strategic considerations relevant to the long-term development of RIECS.

- **Connection to policy processes**

The interviewees emphasised that CS has already demonstrated its value through numerous successful initiatives and policy-relevant applications. The primary challenge is therefore no longer proving its usefulness but creating mechanisms that enable existing capacities to be systematically mobilised and connected to policy processes. While many promising projects and communities exist, the ecosystem remains fragmented and lacks sufficiently coordinated channels for communication with policy-makers.

- **International context**

The interviews highlighted the importance of situating RIECS within a broader international context, as CS does not operate independently from wider developments in science policy, research funding, environmental governance, and international cooperation. The interviewees stressed the importance of foresight and strategic positioning within the changing patterns of investment in science and innovation, increasing global competition in scientific infrastructures, and the growing role of countries and institutions operating at a global scale.

- **Governance as core component**

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Governance is not as a secondary organisational concern but as a core component of infrastructure design. The interviewees highlighted that a technical infrastructure alone is insufficient and that issues related to data ownership, stewardship, access rights, accountability, and conflicts of interest require careful consideration from the outset.

- **Trust and Validation**

According to the interviewees, policy-makers often question how citizen-generated information can be validated and how they can assess its quality. Trust and verification are a prerequisites for policy uptake, and this points to the need for transparent quality assurance procedures, recognised verification mechanisms, and common standards capable of strengthening confidence in CS data at both European and international levels.

- **A broader interpretation**

Finally, the interviewees encouraged a broader interpretation of CS applications. Together with environmental monitoring, CS is potentially relevant to climate adaptation, disaster response, conflict-related damage assessment, and other societal challenges that require distributed data collection and community engagement. However, these opportunities raise important ethical, governance, and security considerations that should be addressed in the development of RIECS.

In technical terms, dominant requirements include:

- Centralized and easily accessible platform for discovering citizen data
- Standardized formats and tools to enable interoperability with official statistics
- Mechanisms to integrate citizen-generated data into policy and reporting processes
- Improved coverage and disaggregation, especially for underrepresented populations
- Coordination tools to reduce duplication and connect stakeholders
- Enhanced visibility and awareness of existing citizen data initiatives
- Data outputs tailored for decision-making (e.g., dashboards, indicators)

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2.4. APPEC Strategy 2027-2036: Open Science & Citizen Science Working Group

2.4.1. Contextual Background

APPEC is a consortium of funding agencies, national government institutions, and institutes from 18 European countries, responsible for coordinating and funding national research efforts in astroparticle physics. The APPEC General Assembly gathers heads of agencies around Europe and observers from international organizations such as CERN, ESO, Astronet, EPS-HEPP, NuPECC and ECFA, to coordinate a collective European strategy for astroparticle physics, execute the recommendations of the roadmap and to create a forum where future actions are discussed and common endeavours emerge.

In 2025, as part of her RIECS-Concept responsibilities, CSZ's Director of Research joined the "APPEC Strategy 2027-2036: Open Science & Citizen Science Working Group" (APPEC WG), established to explore how these two approaches could strengthen the future strategy of European astroparticle physics and to formulate recommendations for the APPEC Strategy 2027–2036. (Note: preparatory engagement started as early as Jan 2025, before the proper start of T4.4).

APPEC WG's core aim was to clarify the scientific role of CS and its infrastructural and policy requirements. In particular, the group sought to move beyond the common perception in this field of CS as outreach, and instead position it as a genuine research methodology capable of contributing uniquely to astroparticle physics research

To support this goal, the working group analysed the current landscape of CS activities relevant to astroparticle physics, reviewed existing initiatives and infrastructures, collected examples of CS use cases, and developed a survey to gather input from APPEC national representatives. A key theme was identifying scientific cases where citizen participation enables research that would otherwise be impossible, for example through distributed detector networks, large-scale data classification, or global observational coverage.

The group also explored concepts such as stable infrastructures for CS, potential flagship initiatives - e.g., frameworks enabling cross-domain or multi-messenger collaborations (coordinated observation and interpretation of multiple signals received from the same astronomical event) - and the role of OS frameworks in enabling data sharing and interoperability across experiments.

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2.4.2. Overview

Period: January–September 2025

Format: Participation in the APPEC Strategy 2027–2036 Open Science & Citizen Science Working Group. This implied participation in regular meetings of the WG (six in total) and contribution to the drafting and revision of the recommendations.

Participants: six WG members, representing 36 international institutions in 18 countries,

2.4.3. RIECS' Role

While RIECS aims at supporting CS across many fields, the APPEC WG addresses the role of CS within a specific scientific domain, astroparticle physics, contributing directly to the broader ecosystem that RIECS aims to build. The two initiatives operate at different scales in a strongly complementary way.

In particular:

- The APPEC WG's effort to frame CS as a legitimate scientific methodology directly supports the strategic vision underlying RIECS. Identifying scientific use cases, analysing the landscape of existing astroparticle physics projects, and proposing strategic recommendations, helps demonstrate the "discipline-specific" scientific value that RIECS-Concept seeks to systematise and scale.
- APPEC WG's activities contribute domain knowledge and community engagement[1] that is valuable for the design of the future RIECS infrastructure. The survey, the discussions of infrastructures (e.g. distributed detector networks), and the WG's strategic proposals provide a concrete case study from a frontier physics domain.
- The emphasis on OS practices, especially FAIR data management, interoperability, and coordination across experiments, is also closely aligned with the RIECS agenda. Astroparticle physics already operates large international collaborations and advanced data-sharing frameworks.

2.4.4. Summary of Findings

The working group produced several concrete outputs for the APPEC strategic process, including the survey and analysis of the European landscape**,** draft strategy text and

[1] Astroparticle physics has a substantial CS community. School detector networks and distributed projects like CREDO engage several thousand active participants each year, and tens of thousands of students and volunteers have contributed to cosmic-ray research over the past two decades.

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recommendations for the next APPEC roadmap, and discussion material for the APPEC Town Meeting in Zaragoza in September 2025.

1. **Survey (32 participants)**

Although the survey did not explicitly mention RIECS, several responses highlight how the astroparticle physics community is already identifying structural challenges that a CS infrastructure like RIECS should help solve, namely:

- fragmentation of infrastructures
- need for FAIR/Open data frameworks
- interoperability of datasets
- stronger European coordination
- societal engagement with science
- handling large, distributed datasets

2. **Recommendations**

The WG articulated key strategic messages that were intended to inform the community discussion and shape the policy recommendations. Recommendations where accepted and they will appear in the APPEC Strategy 2027–2036 (Sep 2026) (see draft in Appendix B).

Strategic recommendations include:

- Support bottom-up CS research initiatives where citizens contribute directly to data collection and analysis (e.g. large-scale cosmic-ray correlation studies).
- Recognise CS as part of the scientific “long tail”, highlighting the need for curation, standardisation, and open access so that citizen-generated datasets become an integral part of the astroparticle physics data ecosystem.
- Develop funding instruments for a global distributed network of cosmic-radiation detectors, including professional, Open Hardware, low-cost, and DIY educational instruments, as a curated “long-tail” infrastructure enabling discovery-oriented research and large-scale collaborative data collection and analysis.
- Ensure stable funding and development of community-driven open-source software and analysis platforms (e.g. CREDO) as testbeds for methodological innovation and long-term scientific value.
- Address epistemic, cognitive, and technical risks in CS (e.g. data quality, biases, heterogeneous instruments) through redundancy, calibration, machine-assisted

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filtering, standardised protocols, mentoring schemes, and structured review mechanisms.

- Embed CS and OS infrastructures in long-term institutional strategies, with stable funding, shared governance, and integration into core research infrastructures.

In essence, CS should be recognised as a legitimate research tool in astroparticle physics, as OS practices are essential for maximising the value of publicly funded research, and Europe could benefit from coordinated frameworks supporting both citizen participation and open access to data and results.

2.5. HEROES Workshop: Advancing Open Science Hardware Ecosystems

2.5.1. Contextual Background

Open Science Hardware (OScH), the open sharing of instrumentation, materials, and other physical tools that enable scientific research, is gaining momentum across disciplines, with over 400 publications featuring OScH designs in the past five years. It is increasingly recognized in major policy frameworks, including the "UNESCO Recommendation on Open Science", and is being supported through conferences and funding initiatives. Communities and organizations such as the Gathering for Open Science Hardware (GOSH), the Open Science Hardware Foundation, the Open Source Hardware Association, and the Research Data Alliance have helped establish the foundations of this growing movement.

Citizen science provides some of the clearest examples of this approach in practice. Distributed cosmic-ray detector networks in schools have demonstrated how open hardware can transform classrooms into real scientific observatories, producing publishable results while supporting education. In environmental science, open sensor platforms have enabled communities to monitor air and water quality, biodiversity, and local climate conditions—often in regions where commercial instruments would otherwise be inaccessible. Open microscopy projects, using locally manufactured open-source microscopes, have allowed citizen scientists and community laboratories to conduct high-quality biological observations and diagnostics around the world. In each of these cases, openness makes hardware understandable, repairable, and adaptable, helping projects scale across geography and time.

RIECS represents an institutional and European-scale framework through which OScH could be applied and scaled within real-world research infrastructures, while also strengthening the connection between open hardware and participatory research. Citizen science projects frequently rely on accessible, low-cost, and adaptable scientific

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tools—such as environmental sensors, monitoring devices, or DIY laboratory equipment. By supporting tools that can be openly shared, locally built, and improved by communities, RIECS could help advance the goals of citizen science: broader participation in research, greater transparency, and improved reproducibility.

2.5.2. Overview

Activity: Workshop at "HEROES Workshop: Advancing Open Science Hardware Ecosystems"

Dates: 19–21 January 2026

Locations: CERN, SDG Solution Space at University of Geneva, and International Telecommunication Union (ITU)

Organised by: The Open Science Hardware Foundation in collaboration with CERN, the SDG Solution Space, CSZ and CSGP (Geneva Hub).

Output: The workshop will produce an event report and briefing materials summarizing key insights, along with a research and action agenda. It will also deliver a 2026 map of the OScH ecosystem highlighting existing assets, expertise, tools, and current gaps. Follow-up virtual sessions and dissemination activities will help refine outcomes and share them with policymakers and international forums.

Participants: More than 100 participants were targeted, representing different stakeholders groups with complementary roles in the context of OScH. Stakeholders included:

- International Organizations (UNESCO, ITU, etc.)
  These institutions contribute to policy frameworks, global governance, and OS initiative
- Research Infrastructures and Scientific Organizations (CERN)
  Are actors shaping OScH policy and implementation.
- Universities and Academic Institutions
  Their typical role is to develop, test, and adopt open hardware, often funded by public research grants.
- Governments and Public Sector and Procurement Bodies
  These stakeholders influence policy, regulation, procurement rules, and funding structures affecting OScH adoption.

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Finally, a selected group of more than 40 international leaders and practitioners participated, representing universities, foundations, international organizations, and research infrastructures (see details in Appendix A)

Format: The format of the workshop aimed at being both rigorous and generative. With 2,5 days, it offered the possibility to participants to address the topics with enough time and in multiple iterations, which is not frequent. Structured sessions were complemented by informal exchanges, shared meals, and a progressive convergence exercise to encourage collaboration across disciplines and perspectives. Dedicated note takers captured the richness of discussion, and on the final day participants worked together to identify priorities for research and action.

Goal: The workshop aimed to address the gap between the growing visibility of OScH and its limited integration within scientific institutions. Selected participants gathered to deepen a shared understanding of the OScH ecosystem and explore how open hardware can become a core component of OS infrastructure, supporting global access to reliable scientific data.

Discussions were designed around four interconnected themes, namely institutions, standards, economics, and ecosystems. These themes highlight how the future of OScH depends not only on technical innovation but also on governance, coordination, and sustainable incentives.

Two domains were chosen to help ground these discussions: participatory science, offers a well-established example of how OScH is already enabling distributed data collection, broader engagement, and community-driven inquiry, and artificial intelligence, where open hardware will be increasingly important to ensure transparency, equity, and reproducibility.

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Figure 4. HEROES participants at CERN Idea Square

2.5.3. RIECS' Role

RIECS co-organised the workshop alongside the Open Science Hardware Foundation, CERN, and the SDG Solution Space, contributing both institutional coordination and substantive expertise. As the primary European framework for citizen science infrastructure, RIECS brought to the workshop a concrete operational perspective on what distributed, community-driven data collection actually requires from instrumentation: reliability across diverse contexts, local maintainability, low barriers to participation, and compatibility with shared data standards. This grounded the more abstract policy discussions about OScH in the realities of running CS projects at scale.

Within the workshop sessions, RIECS shaped the discussion in two specific ways. First, it anchored the participatory science domain, one of the two focal domains chosen to ground the workshop's four thematic discussions (institutions, standards, economics, ecosystems), by providing examples of existing CS infrastructure and identifying where the absence of openly documented, locally repairable hardware creates gaps in coverage and participation. Second, it introduced the European research infrastructure perspective into a conversation that would otherwise have been dominated by individual project experiences, helping participants think about OScH not just as a collection of tools but as infrastructure that requires governance, curation, and long-term institutional commitment.

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The connections built at HEROES, particularly with CERN, UNESCO, ITU, and the Open Science Hardware Foundation, directly strengthen the international stakeholder network that RIECS will need to function as a globally credible infrastructure rather than a purely European one.

2.5.4. Summary of Findings

The distance between OScH and mainstream research infrastructures is less a technical issue than a structural one: the lack of connective infrastructure that allows open hardware initiatives to persist, scale, and integrate with institutional research systems. HEROES participants believe that addressing this gap presents a clear win–win opportunity for both OScH communities and RIECS. For OScH, such infrastructure would strengthen sustainability, institutional recognition, and collaboration; for RIECS, it would unlock a vibrant ecosystem of participatory tools, distributed innovation, and community-driven instrumentation that can expand the reach and impact of CS infrastructures.

At the same time, RIECS could act as a bridge to institutional adoption. Participants in procurement systems revealed that they frequently perceive open hardware as risky or non-standard, despite its advantages in transparency, adaptability, and sustainability. Recognising OScH as (part of) a legitimate research infrastructure would unlock broader use in CS and institutional projects. In addition, they suggested lightweight open standards promoted through RIECS could improve interoperability, allowing data and tools from multiple contributors to integrate more easily with professional research infrastructures. By also increasing the visibility and connectivity of the OScH ecosystem, RIECS would then strengthen collaboration while benefiting from a dynamic community developing innovative, accessible scientific tools.

International Organizations

Members of International Organizations expressed the aspiration for RIECS to support more inclusive global participation in scientific research. They called for an infrastructure that enables communities in underserved regions to contribute to CS through accessible digital platforms and low-cost scientific instrumentation based on open hardware. They also see RIECS as a vehicle for capacity-building, providing training for local researchers, educators, and community groups. Finally, these participants see RIECS establishing shared data commons that facilitate access to citizen-generated data and support the scalable implementation of OS policies worldwide.

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Research infrastructures

For participants from large research infrastructures and scientific organizations such as CERN, RIECS offers the opportunity to support the development of robust frameworks that enable the large-scale deployment of OScH. In particular, they look for support in establishing common standards that ensure compatibility and reliability across projects, as well as interoperable tool ecosystems that allow instruments, software, and data pipelines to integrate across research initiatives.

This includes distributed manufacturing networks that enable local production, maintenance, and repair of hardware, increasing resilience and accessibility. In this way, CS projects connected through RIECS could serve as large-scale testbeds for testing, validating, and refining new scientific instruments and technologies.

Governments, public sector institutions, and procurement bodies

Public officials count on RIECS to support evidence-based policy. They value monitoring infrastructures (e.g. environmental or health sensing systems) that enable large-scale data collection for public services, as well as open procurement frameworks and standardized hardware specifications that facilitate the adoption of transparent technologies. They believe that CS initiatives connected through RIECS can increase public engagement in research, reduce dependency on proprietary technologies, and provide support for local manufacturing and maintenance networks.

Academic Institution

For academic stakeholders, RIECS can address existing fragmentation and support more effective use of OScH. Recurring needs include shared repositories of validated hardware designs, documentation, and good practices that reduce duplication of effort across universities and research groups. They also seek testing and validation facilities and training programs, such as workshops and teaching curricula, that support skills development and integrate CS into education. Finally, they expressed the need for collaborative experimentation platforms that connect university laboratories with CS initiatives through shared instrumentation and infrastructures.

TTOs and OSPOs

Participants from Technology Transfer Offices (TTOs), Innovation Offices, and Open Source Program Offices (OSPOs) highlighted the need for RIECS to support the governance, management, and adoption of open technologies within research organisations. They want frameworks that help reconcile OScH practices with institutional intellectual property policies, and help translate research prototypes into sustainable innovation. This includes

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support for developing policies, best practices, and capacity-building activities that help organizations adopt and manage open hardware and open-source contributions. Through RIECS, their respective offices could strengthen connections between academia, industry, and policy stakeholders, facilitating collaboration and demonstrating the economic and societal value of open technologies.

3. High-level Synthesis

This section attempts an initial consolidation of the findings of the five engagement streams into a single set of design requirements for RIECS, organised by stakeholder logic rather than by event. Across very different settings, the requirements expressed by international stakeholders converge on a remarkably consistent picture of what RIECS should be.

First and foremost, RIECS is asked to be a connective infrastructure, not a new silo. The international stakeholders engaged through Task 4.4 consistently described RIECS as the missing layer that would allow what already exists (including projects, datasets, instruments, communities, networks, policy frameworks) to interoperate, scale and become usable for evidence-based policy. The UNITAR interview captures this most concisely: the core need *"is not just more data, but a functioning ecosystem, one that makes citizen data visible, accessible, interoperable, and usable for policy, while reducing fragmentation and improving coordination."* The APPEC survey, the HEROES findings and the UNEA-7 advocacy work all converge on the same diagnosis, framed in their respective vocabularies (long-tail science[2], OScH ecosystem gap, MEA implementation gap).

This convergence is significant for the EC because it suggests that a single, well-designed European RI can address requirements from very different international communities simultaneously, provided that its connective and standards-based functions are prioritised.

3.1. Requirements clustered by function

From an initial analysis of the findings from the different activities, as performed by the partners responsible for T4.4 (CSZ and CSGP), five functional clusters emerge from the engagements described above that should help structure the requirements catalogue (KER 1).

[2] While most scientific output and data come from a few large, well-funded projects (the "head"), the "tail" includes contributions from smaller labs, niche projects, and increasingly, CS initiatives. These contributions may not generate immediate, high-impact discoveries on their own, but over time and in combination, they provide a rich resource for cross-comparative studies, data mining, and hypothesis testing, typical of long-tail scientific value.

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Discovery, visibility and aggregation

International stakeholders consistently ask for a single entry point that allows them to find citizen-science projects, datasets, methodologies and tools relevant to a given policy question. UNITAR explicitly lists *"a centralised and easily accessible platform for discovering citizen data"* and *"enhanced visibility and awareness of existing citizen-data initiatives"* among the dominant requirements; the UNDESA workshop user stories repeat the same need from the perspective of NSO and UN bodies; and the HEROES workshop calls for a 2026 map of the OScH ecosystem that RIECS could host or federate.

Standards, interoperability and data integration

This is the most frequently expressed requirement. UN partners frame it as interoperability between citizen-generated data and official statistics, building on the Copenhagen Framework on Citizen Data endorsed by the 56th UN Statistical Commission. Research-infrastructure partners (APPEC, CERN) frame it as FAIR data, common protocols and shared analysis platforms across distributed detector networks. The HEROES community frames it as open standards and interoperable tool ecosystems for hardware, software and data pipelines.

Capacity building, inclusion and the Global South

International organisations are unambiguous that an EU-funded RI cannot be conceived as a closed European service. UNESCO, ITU, FAO, UNITAR and UNDP-linked actors all express the requirement that RIECS should support inclusive global participation, including communities in underserved regions, through accessible digital platforms, low-cost open-hardware instruments and capacity-building programmes for local researchers, educators and community groups. The HEROES user stories make the same point in the OScH register ("support for Global South participation"), and the UNDESA workshop highlighted persistent data gaps for marginalised populations (people with disabilities, informal communities).

Policy-ready outputs and integration with governance frameworks

The UNEA-7 work in particular demonstrates that international stakeholders need RIECS to deliver decision-ready outputs: dashboards, indicators, evidence briefs, policy-ready datasets, and structured pathways into existing governance instruments such as Multilateral Environmental Agreements, the SDG indicator framework and national reporting cycles. UNITAR's interviewees explicitly request *"data outputs tailored for decision-making (e.g., dashboards, indicators)"* and *"mechanisms to integrate citizen-generated data into policy*

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and reporting processes". The UNEA-7 advocacy work proposed a UN-level expert mechanism on CS and MEAs as one such pathway.

Open Science Hardware as infrastructure

The HEROES workshop, complemented by the APPEC recommendations and by the UNEA-7 demonstrations of wearable air-quality monitors, establishes that OScH is a crucial part of the infrastructure stack of CS. International organisations value OScH for global participation and digital sovereignty; research infrastructures value it for long-term maintainability and avoidance of vendor lock-in; governments value it for transparent procurement and local manufacturing; academia values it for reproducibility and cost-effectiveness.

Governance, sustainability and institutional adoption

A final cluster, voiced strongly in the APPEC working group and echoed in the UNEA-7 and HEROES discussions, concerns the institutional fate of RIECS itself. International actors will only commit to interoperate with an infrastructure that they expect to last. They therefore ask for stable funding, shared governance, integration into core research-infrastructure programmes and an explicit pathway from project (RIECS-Concept) to operational RI. APPEC's draft recommendations (Appendix B) state this in explicit terms, calling for embedding CS and OS infrastructures *"in long-term institutional strategies, with stable funding, shared governance, and integration into core research infrastructures"*.

3.2. Requirements by stakeholder type

Beyond the functional view, the engagement allows a refinement of the TG10 category defined in the proposal. Three sub-types of international stakeholder emerge, each with a distinct requirements profile, as illustrated in the Table 3.

Table 3 Requirements by sub-types of international stakeholder

Sub-type	Examples engaged in T4.4	Dominant requirements
UN agencies and statistical bodies (NSO)	UNDESA, UN ESCAP, UNITAR, UNEP, CBD, UN Major Groups, UNSPBF, ITU, FAO, UNESCO	Discovery, interoperability with official statistics and SDG indicators, integration with MEAs, policy-ready outputs, capacity building, inclusion

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Sub-type	Examples engaged in T4.4	Dominant requirements
International research infrastructures and scientific organisations	CERN, APPEC, ESO/Astronet/EPS-HEPP/NuPECC/ECFA (via APPEC)	FAIR / OS practices, common standards and interoperability, distributed instrumentation, recognition of CS as legitimate methodology, long-term curation of long-tail data
Global policy-adjacent and ecosystem organisations	Open Science Hardware Foundation, Alfred P. Sloan Foundation, CURIOSS / OSPOs, FieldKit, Safecast, AI Crowd, Seeed Studio, Open Know-How, OpenFlexure	Open standards, shared design libraries, distributed manufacturing, IP and governance frameworks, pathways from prototype to sustainable innovation

These sub-profiles are helpful not only to assign requirements to the right design components, but also to build a more granular impact-assessment framework (KER 5).

3.3. Cross-cutting issues

Several issues run across the activities reported in Section 3 and across the requirement clusters identified in Section 4. As they cannot be assigned to a single component of RIECS, they need to be addressed transversally in the conceptual design, in the sustainability roadmap and in the impact-assessment framework.

Trust, data quality and standardisation

International stakeholders often raised the question of trust in citizen-generated data. In particular, NSOs were explicit that uptake hinges on reliability, comparability and governance; APPEC raised “epistemic, cognitive, and technical risks (e.g. data quality, biases, heterogeneous instruments)” and proposes mitigation through “redundancy, calibration, machine-assisted filtering, standardised protocols, mentoring schemes, and structured review mechanisms”; the UNEP / MEA work depends on data robust enough to inform legally meaningful decisions. Trust is therefore a structural property of the infrastructure that must be engineered through validation pipelines, methodological harmonisation, transparent provenance, and explicit quality and uncertainty tagging at the metadata level.

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Inclusion, equity and the Global South

Inclusion appears, with different framings, in every engagement: disaggregation of marginalised populations (UNDESA), participation of underserved regions (HEROES, UNESCO/ITU), accessibility of OScH (Global South user stories), and gender balance (consistent with the proposal's gender plan). While RIECS will be a European RI, international actors expect it to operate as a "global" public good in its services, its standards and its accessibility. Inclusion has architectural consequences (e.g. offline-capable interfaces, multilingual content, low-bandwidth modes) and governance consequences (e.g. representation of non-EU voices in advisory bodies). It also has impact-assessment consequences that should be reflected in KER 5 indicators.

The science–policy–society interface

RIECS is not conceived as a science-policy interface itself. Rather, it is envisioned as an enabling infrastructure that allows CS data, methods, communities, and technologies to contribute more effectively to existing science-policy and science-policy-society interfaces operating at European and global scales (see Appendix C).

So the primary challenge is no longer the production of CS data itself, but the existence of effective channels through which such knowledge can inform scientific research and policy processes. In particular, the UNEA-7 advocacy, the proposed UN-level expert mechanism on CS and MEAs, and the UNITAR work on integrating citizen data into the 2030 Agenda all describe RIECS not only as a research-infrastructure but as a node in a science-policy-society infrastructure.

This dual identity has implications for staffing (policy-fluent personnel, not only technical staff), for outputs (policy briefs, indicators, expert support) and for governance (involvement of policy actors in RIECS bodies). It also implies that the impact-assessment framework should track policy uptake as a first-order indicator alongside scientific and technological metrics.

Open Science and Open Science Hardware as design defaults

For all stakeholders, OS is a baseline expectation rather than an added value, and OScH extends this expectation to instrumentation. RIECS will be evaluated by international partners on its alignment with the UNESCO Recommendation and with Open-Hardware norms, and this needs to be reflected in service-level commitments, in procurement guidance and in the standards adopted.

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Governance as Infrastructure

A recurring insight (emerging especially from the interviews) was that governance should be understood as a core component of infrastructure rather than as a separate organisational layer. While RI are often discussed primarily in terms of technical platforms, data services, and operational capabilities, international stakeholders repeatedly emphasised issues of ownership, stewardship, trust, accountability, access, and quality assurance. From this perspective, governance mechanisms are not simply instruments for managing an infrastructure; they are part of the infrastructure itself, enabling collaboration, interoperability, legitimacy, and long-term sustainability. For RIECS, this suggests that governance frameworks, data stewardship arrangements, verification procedures, and participation models should be considered foundational infrastructure components alongside technical systems and services.

Sustainability beyond the project

What happens after RIECS-Concept? The APPEC recommendations explicitly call for embedding CS and OS infrastructures “in long-term institutional strategies, with stable funding, shared governance, and integration into core research infrastructures”; HEROES highlights how procurement bodies perceive open hardware as risky absent institutional anchoring; UNITAR’s user stories assume a continuing service.

UNSPBF highlighted the importance of considering the broader geopolitical and economic environment in which RIECS will operate, which is changing international research priorities and increasing global competition in scientific and digital infrastructures. Sustainability should be understood not only in financial and organisational terms, but also as the capacity of RIECS to remain strategically relevant within a rapidly evolving international landscape. For a credible sustainability story, RIECS should respond with a clear lifecycle plan including hosting arrangements, governance, and financing model (and hopefully integration with ESFRI).

3.4. Policy contributions

Table 5 Overview of the policy contribution of each activity.

Activity	Contribution
RIECS-Concept Workshop at the 4th Expert Group	The workshop generated requirements for integrating citizen-generated data into official data ecosystems and policy processes. Discussions - focused on interoperability, trust, quality assurance, metadata standards, and institutional uptake -

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Meeting on Citizen Data	strengthened the alignment of RIECS with international efforts to support inclusive and participatory data systems.
UNEA-7 Preparations and Participation	The UNEA-related activities explored pathways for embedding CS within global environmental governance and multilateral policy processes. They highlighted opportunities for CS to contribute to biodiversity monitoring, environmental reporting, and science–policy interfaces, reinforcing the role of RIECS as a provider of policy-relevant evidence and coordination mechanisms.
Interviews (UNITAR and UNSPBF)	The interviews provided strategic insights into governance, sustainability, trust, verification, and policy uptake of citizen science. They highlighted the need for robust stewardship mechanisms, internationally recognised quality assurance approaches, and long-term institutional anchoring, reinforcing the vision of RIECS as a trusted infrastructure connecting science, policy, and society at European and Global scales.
HEROES Workshop: Advancing Open Science Hardware Ecosystems	The workshop explored the role of open science hardware as an enabling component of CS infrastructures. The activity identified requirements related to accessibility, interoperability, technological sovereignty, local capacity building, and the long-term sustainability of scientific instrumentation, particularly in underserved regions.
APPEC Strategy 2027–2036: Open Science & Citizen Science Working Group	The working group explored how CS can be recognised as a legitimate scientific methodology within large-scale research infrastructures. The activity generated recommendations related to interoperability, open data, long-term governance, distributed infrastructures, and sustainable community-driven tools, providing valuable input for the positioning of RIECS within the European RI landscape.

3.5. Criticalities and Potential Tensions

The engagement activities reported in this deliverable revealed a strong convergence around the need for a federated, policy-relevant, and globally connected CS infrastructure. At the same time, they also exposed a number of criticalities and tensions that RIECS will need to navigate as part of its conceptual development.

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European Infrastructure vs Global Relevance

RIECS is being developed as a European Research Infrastructure, yet many stakeholders emphasised that the challenges addressed by CS, including climate change, biodiversity loss, disaster risk reduction, and sustainable development, are inherently global. International organisations repeatedly stressed the importance of supporting participation beyond Europe, particularly in underserved regions. This raises questions regarding the geographical scope of services, governance representation, and resource allocation. RIECS will need to balance its European mandate with the expectation that it contributes to global CS ecosystems and international policy processes.

Governance vs Technical Development

A recurring message from interviews and workshops was that governance should be considered part of the infrastructure itself rather than a separate organisational layer. Stakeholders repeatedly raised questions concerning ownership, accountability, stewardship, trust, and decision-making. While technical services and platforms are often the most visible elements of research infrastructures, the long-term success of RIECS may depend equally on its governance arrangements. This suggests a need to balance investment in technical capabilities with investment in governance frameworks and institutional partnerships.

Trust and Verification vs Participation and Accessibility

Policy actors consistently identified trust, quality assurance, and verification as prerequisites for integrating citizen-generated evidence into decision-making processes. However, increasing requirements for validation, standardisation, and certification may also create barriers for smaller organisations, grassroots initiatives, and communities with limited resources. RIECS will need to develop trust-building mechanisms that enhance credibility while remaining accessible and inclusive.

Policy Relevance vs Scientific Independence

International organisations expressed strong interest in policy-ready outputs, including indicators, dashboards, reporting mechanisms, and evidence products that can support decision-making. At the same time, CS communities and research organisations emphasised scientific openness, experimentation, and community-led innovation. RIECS will need to support pathways towards policy uptake without reducing CS solely to a policy-monitoring instrument or constraining scientific creativity and societal engagement.

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Long-Term Sustainability

A recurring message across all engagement activities was that stakeholders are willing to invest time, resources, and interoperability efforts only if RIECS is perceived as a stable and durable institutional actor. Long-term sustainability therefore emerged not merely as an operational consideration but as a prerequisite for adoption. Participants repeatedly emphasised the importance of clear governance arrangements, sustainable funding models, and long-term institutional anchoring beyond individual project cycles. Strategic questions include potential membership structures, the role of national and thematic nodes, relationships with existing CS associations and networks, integration with EOSC and other research infrastructures, and mechanisms for ensuring sustainable funding and stewardship.

4. Consolidated requirements

While several requirements identified through Task 4.4 overlap with those expressed by other stakeholder groups, international organisations and global policy actors placed particular emphasis on interoperability with governance frameworks, policy uptake, trust, institutional sustainability, and mechanisms that enable citizen science to contribute to international reporting and decision-making processes.

The table below summarizes such requirements as they emerged in the engagement activities with international stakeholders.

Table 6 7.6. Specific requirements emerging from international stakeholder engagement

Stakeholders need	Consolidated requirement	Source
Need to connect citizen-generated data with official national and international data systems in order to complement official statistics and support evidence-based decision-making.	Interoperability with official statistical systems.	Citizen Data Workshop (UNDESA, UN ESCAP, NSOs); UNITAR interview
Need to use citizen-generated data within global sustainable-development monitoring and reporting processes.	SDG indicator interoperability and reporting integration.	Citizen Data Workshop; UNITAR interview; UNEA-7 discussions

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Need to support the implementation, monitoring, and reporting of international environmental agreements through citizen science.	Interoperability with environmental governance frameworks, including MEAs, CBD, and the Kunming–Montreal Global Biodiversity Framework.	UNEA-7 activities; CBD-related discussions
Need for evidence products that can be directly used by policy-makers and public institutions rather than raw datasets alone.	Policy-ready outputs such as dashboards, indicators, maps, and evidence briefs.	UNITAR interview; UNEA-7; Citizen Data Workshop
Need for clear mechanisms through which citizen science evidence can enter policy and reporting processes and contribute to decision-making.	Integration pathways into policy processes, reporting systems, and existing science-policy interfaces.	UNEA-7; UNITAR interview; UNSPBF interview
Need to establish confidence in citizen-generated evidence among governments, public institutions, and international organisations.	Trust and verification framework for citizen-generated data and evidence.	UNSPBF interview; UNITAR interview; Citizen Data Workshop
Need to ensure that citizen science infrastructures and services are relevant and accessible beyond Europe, particularly in underserved regions and the Global South.	Global inclusion and participation mechanisms, including support for underserved regions and Global South actors.	HEROES workshop; UNEA-7; UNITAR interview
Need for long-term institutional legitimacy, stewardship, accountability, and sustainability beyond individual projects and funding cycles.	Governance, stewardship, and long-term institutional anchoring of RIECS.	UNSPBF interview; APPEC Working Group; UNITAR interview; UNEA-7

5. Conclusions

Task 4.4 successfully engaged UN agencies, international organisations, and research institutions in shaping the design of RIECS, producing a range of concrete outputs including

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policy recommendations, user stories, ecosystem mapping, workshop findings, and strategic interviews. These contributions confirmed strong international interest in RIECS and provided direct input into its requirements catalogue, conceptual design, governance planning, and sustainability roadmap. The engagement demonstrated that stakeholders see RIECS not as an isolated European initiative, but as a globally connected infrastructure aligned with international policy, research, and CS frameworks.

The findings point to a clear design direction for RIECS: a federated, standards-based infrastructure that connects existing CS platforms, datasets, tools, and communities rather than replacing them. Stakeholders stressed the importance of interoperability with frameworks such as FAIR/CARE, the UNESCO Open Science Recommendation, SDG indicators, and multilateral environmental agreements. The infrastructure is also expected to integrate Open Science Hardware, provide policy-ready outputs, and support CS as a legitimate research methodology through strong governance, curation, standardisation, and evaluation processes. Long-term sustainability, institutional anchoring, and policy relevance emerged as essential conditions for international trust and adoption.

To succeed with its global dimension, the project should maintain and deepen relationships with international organisations and policy networks to ensure continued uptake and visibility. Indeed, D4.4 concludes that there is a clear international demand for RIECS, but that this demand depends on the infrastructure being open, inclusive, interoperable, policy-connected, and sustainable from the outset. Integration with global standards and institutions is therefore presented not as an optional extension, but as a core requirement for building an effective and credible research infrastructure for CS.

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Appendixes

Appendix A: HEROES details

Participants

A selected group of more than 40 international leaders and practitioners representing universities, foundations, international organizations, and research infrastructures. It included representatives of:

- International organizations
    - UNESCO
    - UN agencies
    - FAO
    - International Telecommunication Union (ITU)
- National and international research and scientific institutions
    - CERN
    - Carnegie Mellon University
    - University of Geneva
    - Pontificia Universidade Católica Campinas
    - University of Sussex
    - Foundations
    - Alfred P. Sloan Foundation
- Collaborative research networks - These networks coordinate open source program offices and institutional open-source policies.
    - CURIOSS (Community of University and Research Institute OSPOs)
- Key Ecosystem Organizations and Projects
    - Open Source Hardware Foundation (OSHF)
    - FieldKit
    - Safecast
    - AI Crowd

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- Seeed Studio
- Open Know-How data model
- OpenFlexure project

User Stories

As a	Task / Need	Goal / Expected Outcome
International Organization	Global OS policy	To promote OS principles and equitable access to research tools worldwide
International Organization	Support for Global South participation	To enable scientific capacity in low-resource regions.
International Organization	Digital sovereignty and public infrastructures	open hardware should be part of national technological autonomy
International Organization	Support the SDGs	To support education, environmental monitoring, and public health initiatives
international Research Infrastructures / Scientific Organization	Technological sovereignty	To retain control over critical technologies rather than depending on proprietary vendors
international Research Infrastructures / Scientific Organization	Long-term maintainability	To have tools that are repairable and modifiable over long scientific lifecycles
international Research Infrastructures / Scientific Organization	Global collaboration	To provde shared designs and interoperable tools across countries and institutions to allow for large scientific projects.
international Research Infrastructures / Scientific Organization	Standardization and interoperability	Institutions like CERN promote standards to enable collaboration and avoid vendor lock-in.
Academic Institution	Research infrastructure and scientific tools	Universities use OScH to build custom research instruments and reduce dependency on expensive proprietary equipment.
Academic Institution	Lower-cost research tools	Lower costs and better ROI - Open hardware can be much cheaper than commercial

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		alternatives, sometimes cited as 87–94% cheaper
Academic Institution	Customizable instrumentation - Reproducible science Customization for experiments	Researchers want hardware that can be adapted to specific experimental needs, which commercial tools often cannot provide.
Academic Institution	OS and reproducibility	Universities see open hardware as supporting reproducibility and collaboration in science.
Public Procurement Bodies	Transparent procurement	Open hardware can reduce corruption and "vendor lock-in" in procurement processes.
Government / Public Sector	Economic sovereignty	Governments want technologies that remain functional even under trade restrictions or geopolitical tensions
Government / Public Sector	Better value for public spending	OScH can reduce costs and allow local manufacturing and maintenance.
Government / Public Sector	Policy leverage	Governments can promote open hardware through standards and procurement rules.

Appendix B: APPEC recommendations

APPEC recommends:

- the strategic implementation of fully supported bottom-up participatory research initiatives (CS projects) where citizens contribute directly to scientific research by performing volunteer data collection and/or analysis, such as large-scale cosmic-ray correlation studies
- the recognition of CS as part of the "long tail", to emphasize the strategic importance of curation, standardization, and open access to these datasets. This encourages the scientific community to treat these contributions not as peripheral or anecdotal, but as integral components of the broader data ecosystem. When properly integrated, citizen-generated data can fill observational gaps, provide supplementary validation, and enable large-scale collaborations—enhancing the collective progress of astroparticle physics.

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- the creation of instruments for financial support for a distributed, technologically diverse global network of cosmic radiation detectors—including professional, low-cost, and educational instruments—as a new type of curated „long tail" research infrastructure for discovery-oriented research. This network would enable scientific investigations in an open research ecosystem that would otherwise be impractical or impossible (e.g. crowdsourced data mining, classification, labelling, and/or data collection).
- the stable funding and further development of community-developed open-source software and analysis frameworks platforms (such as the Cosmic Ray Extremely Distributed Observatory, CREDO), to support their use as testbeds for methodological innovation and to ensure long-term scientific value.
- CS in astrophysics offers major value but comes with epistemic, cognitive, and technical risks, including - among others - data-quality inconsistencies, expertise gaps, human biases including resistance to paradigm shifts (c.f. Kuhn's opaque paradigms), heterogeneous instruments, software and platform inconsistencies. These challenges are mitigated through redundancy and consensus methods, calibration with known or synthetic events, machine-assisted filtering, standardised protocols, statistical debiasing, and more. APPEC further supports mentoring schemes, anomaly-review pathways, and initiatives such as the proposed Breakthrough Committee. With these safeguards, citizen contributions become reliable and a strong complement to professional astrophysics.
- Long-term sustainability of CS and open-science infrastructures requires embedding them in institutional strategies and adopting durable governance models. APPEC encourages member institutions to develop stable hosting arrangements and to integrate distributed detector networks, citizen-science platforms, and open-software ecosystems into their core scientific missions, recognising them as evolving research infrastructures. Their continuity depends on secure operational funding, shared governance, and formal institutional commitments. The proposed Open Multi-Messenger Organisation (OMMO, a role which could be taken by APPEC itself if permitted by its current legal governance structures) could offer a unifying framework to coordinate and support these efforts across domains, ensuring lasting value beyond individual project cycles. Scientifically-driven crowdsourced data labelling and data collection via citizen science to create AI training sets (or refine AI outputs) should form part of the EU's aspiration for a "CERN for AI", currently termed RAISE.

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Appendix C: Science-policy and science-policy-society interfaces

RIECS is not conceived as a science-policy interface itself. Rather, it is envisioned as an enabling infrastructure that allows CS data, methods, communities, and technologies to contribute more effectively to existing science-policy and science-policy-society interfaces operating at European and global scales.

The primary purpose of Science–Policy Interfaces is to connect scientific evidence with policy and decision-making processes. Main actors include scientists, experts, policy-makers, governments, and international organisations and their typical functions include scientific assessments, evidence synthesis, policy advice, reporting, and consensus-building. Example relevant to RIECS include:

- Intergovernmental Panel on Climate Change (IPCC)
- Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)
- United Nations Statistical Commission
- CBD Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA)
- UNEP Science Division

Science–Policy-Society Interfaces add to the process stakeholders from society at large, including citizens, communities, NGOs, Indigenous Peoples, and International Organisations. Their functions extend to participation, co-design, co-production of knowledge, dialogue, deliberation, capacity building, and societal engagement. Example relevant to RIECS include:

- UNEA Major Groups and Stakeholders (MGS) (the formal stakeholder engagement framework used by the United Nations Environment Programme and the United Nations Environment Assembly)
- IPBES stakeholder engagement (includes open calls, stakeholder days, participatory assessments, and accredited observer participation coordinated through the IPBES Stakeholders Portal)
- European Network of Living Labs (Living Labs are user-centered innovation ecosystems that bring together researchers, governments, businesses, and citizens to co-create and test solutions in real-world settings)
- Horizon Europe Mission Communities (support stakeholder participation around the EU Missions on climate adaptation, cancer, oceans and waters, climate-neutral cities, and soil health).

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