



METHOD ARTICLE

REVISED **Rethinking science-policy-practice interaction for transformative sustainability research and innovation in Europe**

[version 2; peer review: 3 approved]

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v2 **First published:** 12 Nov 2025, 5:351
<https://doi.org/10.12688/openreseurope.21755.1>
Latest published: 14 Jan 2026, 5:351
<https://doi.org/10.12688/openreseurope.21755.2>

Abstract
Impactful knowledge generation and utilisation, aiming at addressing environmental and sustainability challenges, requires meaningful interaction between scientists, stakeholders, policymakers and society. This study identifies key success factors and challenges at the science-policy-practice interaction, drawing on document analysis, interviews, and workshops involving experts, policymakers, and funders of environmental and sustainability research and innovation across 14 European countries. Experiences from current practices highlight the highly variable contexts for interaction and communication throughout Europe, a diverse range of tools and approaches, and differing levels of available resources. Siloed structures and the need to engage various societal sectors and levels of governance remain significant challenges. The development and employment of expertise in communication, interaction and knowledge co-creation, capable to orchestrate this variability, is essential. Greater recognition of the diverse dimensions of inclusive participation is proposed to ensure that environmental and sustainability research and innovation, aimed at societal

Open Peer Review

Approval Status

	1	2	3
version 2			
(revision)	view	view	view
14 Jan 2026	↑	↑	
version 1			
12 Nov 2025	view	view	

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 - 2. **Aktham Maghyreh** , United Arab Emirates University, Al Ain, United Arab Emirates
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- Any reports and responses or comments on the

transformation, leaves no one behind.

article can be found at the end of the article.

Plain Language Summary

Sustainability science is only useful if it reaches the people who make decisions about climate, ecosystems, or resources. The present study therefore set out to investigate how scientists, policymakers, and society actually interact in Europe—a continent remarkably diverse in terms of politics, culture, and resources—and what makes these interactions succeed or fail. The work draws on desk reviews, semi-structured interviews with approximately 300 experts (researchers, politicians, and funding bodies) across fourteen European countries, and workshops where participants tested the findings. The aim was to learn from real-world situations: the communication tools used, their funding mechanisms, and the practices and structures that facilitate or hinder dialogue. A key claim is that without inclusive, broad-based dialogue, European sustainability science risks remaining a collection of isolated projects rather than a coordinated engine for societal transformation.

Keywords

Communication, Innovation, Interaction, Science, Sustainability, Participation, Policy, Transformation



This article is included in the [Horizon Europe gateway](#).

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Competing interests: No competing interests were disclosed.

Grant information: This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101131520 (Collaborative Action coordinating and enhancing systemic, actionable and transversal Sustainability Research and Innovation [CASRI]).

The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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How to cite this article: Lyytimäki J, Kunttu L, Bartke S *et al.* **Rethinking science-policy-practice interaction for transformative sustainability research and innovation in Europe [version 2; peer review: 3 approved]** Open Research Europe 2026, 5:351 <https://doi.org/10.12688/openreseurope.21755.2>

First published: 12 Nov 2025, 5:351 <https://doi.org/10.12688/openreseurope.21755.1>

REVISED Amendments from Version 1

The revised manuscript aims to address concerns regarding the original presentation of the study's objectives and methodology, ensuring a more accessible and reproducible research process. Key changes clarify the study's aim: to map existing Science-Policy Interface (SPPI) tools and methods and provide recommendations for their use, rather than developing a new assessment method. The introduction has been edited to clearly introduce the research task, and most changes are found within the significantly expanded Background and Methods section, which details the research process, including stakeholder involvement, interviewee selection (now summarized in [Figure 1](#)), and data generation. To increase transparency, detailed descriptions and links to openly accessible reports outlining data collection, analysis (including interview schemes and workshop agendas), and methodological approaches have been provided. A limitations paragraph has been added, explicitly acknowledging the focus on European experiences. It is now stated that the analysis relies on qualitative expert assessment. Throughout the manuscript, minor language adjustments have been made to improve clarity.

Any further responses from the reviewers can be found at the end of the article

Introduction

Communication and interaction are essential for efficient knowledge generation and utilisation, which are at the heart of the sustainability transition. Various assessments and scientific studies have shown that the evidence base for decision-making is already sufficient to justify rapid and large-scale transformative action (e.g. [EEA, 2019](#); [EEA, 2025](#); [Kallis *et al.*, 2025](#)). However, this evidence has not yet translated into actionable change capable of slowing down or even eradicating unsustainable pressures on climate ([IPCC, 2023](#)), biodiversity ([IPBES, 2024](#)), or resource use ([UNEP, 2024](#)).

In other words, the great acceleration of environmental pressures continues despite science-based calls for sustainability transition ([Steffen *et al.*, 2015](#)). These calls have been made repeatedly in various forms, from the 1972 United Nations Conference on the Human Environment in Stockholm to the 1992 Earth Summit in Rio de Janeiro and from the eight Millennium Development Goals targeting 2015 to the seventeen Sustainable Development Goals (SDGs) targeting 2030. These calls and processes have gained episodic media attention, influencing public and policy agendas ([EEA, 2021](#); [Holt & Barkemeyer, 2012](#)). This, in turn, has partly shaped priorities in research and innovation (R&I) activities in global, European and national levels. However, the impacts have been insubstantial. For example, the SDGs have influenced societal development primarily on a discursive level by repackaging existing initiatives using the language of the SDGs, rather than initiating transformative action ([Biermann *et al.*, 2022](#); [Lyytimäki *et al.*, 2025](#); [UN, 2025](#)).

Addressing sustainability transitions requires navigating a poly-crisis of climate change, biodiversity and habitat loss and the impact of environmental pollution on human and ecosystem

health as well as crises in the political, economic and social spheres, the 'slowbalisation' of the global economy and trade and growing societal fragmentation over values and identities ([EEA, 2023](#)). Misinformation and disinformation, exacerbated by social media, as well as the rise of populism and outright science denial, are challenges for communicating this evidence to decision-makers ([Ekberg *et al.*, 2022](#)). Rapidly evolving communication and interaction applications employing machine learning and artificial intelligence bring in new possibilities but also unforeseeable risks. Despite the increasing knowledge base on environmental and sustainability issues, prospects for coherent and forward-looking evidence-based decision-making might be eroding in the 2020s. The tension between the abundance of knowledge and the lack of political and societal uptake has been described as the 'knowledge–action gap' ([Räsänen *et al.*, 2024](#)). Addressing this gap requires moving beyond evidence accumulation towards processes that co-produce actionable knowledge.

Here we review recent experiences of science-policy-practice-interaction (SPPI) across Europe and call for a genuinely inclusive and just approach to ensure that sustainability research and innovation benefits all. Our primary aim is to map and synthesize the approaches, tools and methods currently employed for environmental and sustainability SPPI, and to formulate recommendations for enhancing their effectiveness. We focus on Europe but aim to draw lessons that are widely applicable across different regions and topics of communication. This study is motivated by sustainability transition literature ([Köhler *et al.*, 2019](#); [Vähäkari *et al.*, 2020](#)) and rooted in the literatures of science communication and interaction. Communication and interaction have received relatively little attention in transition studies despite being at the heart of transition processes such as innovation diffusion and knowledge utilisation. However, they offer valuable insights and lessons relevant to sustainability transition. Relevant areas include sub-fields of science communication such as climate communication ([Boykoff, 2011](#)) and sustainability communication ([Godemann & Michelsen, 2011](#)), research on science advice and knowledge brokerage ([Gluckman *et al.*, 2021](#)), knowledge co-creation and citizen engagement ([Huttunen *et al.*, 2022](#)), and risk communication and governance ([Renn, 2008](#)). We draw from these diverse areas to explore the role of communication and interaction within the context of national and European R&I systems in relation to sustainability.

Our main claim is that a more inclusive approach to science-policy practice interaction is needed to make knowledge generation and interaction effective and capable of fully supporting sustainability transformation. We justify the claim based on European examples and experiences of SPPI. The next section describes the materials we draw upon.

Background and methods

We use insights from document analysis, interviews, and workshops with experts in environmental and sustainability research and innovation across Europe. The focus is on practical experiences and concrete examples. The materials were

collected under the EU funded Coordination and Support Action “Collaborative Action coordinating and enhancing systemic, actionable and transversal Sustainability Research and Innovation” (CASRI, www.casri.eu). One of the main aims of the project is to identify good practices and gaps in SPPI across Europe. This aligns with the project’s overall goal to outline a strategic European R&I agenda that stimulates collaboration on key topics for environmental and sustainability R&I and thereby promoting sustainable development in Europe in times of multiple crises.

This study draws on academic literature, desk studies and expert stakeholder views from fourteen European countries and regions, including Austria, Basque Country (Spain), Bulgaria, Flanders (Belgium), Finland, France, Germany, Ireland, Italy, Montenegro, The Netherlands, Slovakia, Switzerland and Wales (United Kingdom). A three-step procedure was developed. First, in each country or region, national contact persons familiar with the local context identified a pool of relevant national key stakeholders. The goal was to assemble diverse national samples of senior experts, representing both the private and public sectors and possessing expertise across a range of sustainability R&I fields, with balanced gender representation (Bartke, 2024). More specifically, stakeholders were expected to have expertise on at least one of the project’s key themes: circular economy, biodiversity and climate, sustainable urbanisation, and energy transition.

Second, national desk studies on the project’s key themes were performed to generate up-to-date national overviews. These studies reviewed key R&I agendas, scanned national funding schemes, and examined relevant aspects of SPPI. This information supported the interviews, which served as the primary source of data. In each country, approximately 20 relevant expert stakeholders were interviewed. Of the interviewees, 43% were female and 57% male. Figure 1 summarises the background of the interviewees.

A semi-structured interview scheme, including detailed instructions to guide the interviews, was prepared (Maring *et al.*, 2025, Appendix C). Following this guidance, all interviews were conducted in national languages and subsequently reported in English. Interviews were conducted during spring and summer 2024. Most interviews were conducted in person; recordings were obtained for nearly all sessions. The interview scheme comprised three main sections: R&I priorities, funding opportunities, and SPPI. The SPPI section included three key questions:

- Please describe what the interaction between science, policy, and practice looks like in your work?
- Please describe what activities and/or organisations in your field of expertise effectively facilitate the interaction between science, policy, and practice? How are you involved in these?
- What are the main challenges for this/these activities and/or organisations at the moment? What can be reinforced or improved? Or should other science policy structures and activities be developed?

An optional question for respondents with significant experience in SPPI was included, aiming to gain a deeper understanding of the capacities needed to improve interaction. Topp *et al.*’s (2018) typology of interaction capacities provided a framework for considering key needs and types of organizations, both nationally and internationally. However, due to time constraints and the breadth of topics covered, none of the fourteen cases was able to fully address the typology during the interviews.

The third step involved initial analysis, national stakeholder workshops designed to review, synthesize, and prioritise the gathered information, and compilation of the results into a single document. Workshops followed a shared general template,

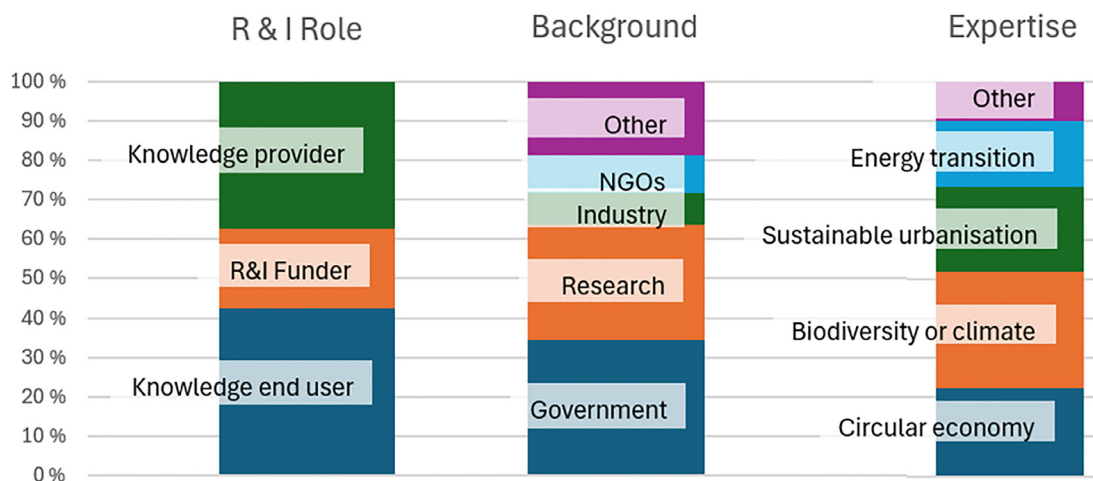


Figure 1. Main roles in research and innovation (R &I) processes, organizational backgrounds and key areas of expertise of the respondents (adapted from Maring *et al.*, 2025). Note:, a single respondent can have multiple roles and affiliations or expertise on multiple themes.

which was adapted to national specificities (Maring *et al.*, 2025, Appendix D). Participants were selected from the interviewees and, on occasion, included additional key stakeholders. The workshops provided participants with an opportunity to summarise, review and reflect on the views of others and highlight the most important issues.

Small teams of nationally based researchers were responsible for initial analysis, organization of interviews and workshops, and data analysis. Recognising the high diversity of national contexts, participant backgrounds, and topics addressed, the analysis relied on qualitative interpretations and aimed to summarize key points related to SPPI for international comparison, following a comparative case study approach (Bartlett & Vavrus, 2016). Cross-country coherence of interpretations was ensured through multiple rounds of review by project coordination, designated theme leaders, and the project's international advisory board. The results were compiled into national comprehensive reviews and synthesised into a single, openly available report, which serves as material for this analysis (Maring *et al.*, 2025). Participants had a final opportunity to check the content of the national reviews via a survey. Content-based errors identified by them were corrected and their further recommendations were documented as an appendix to the final report.

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While the approach did not constitute a full-scale transdisciplinary co-production process, it sought to capture multiple perspectives and highlighted potential tensions between knowledge supply and demand. The data collection integrated broad bottom-up stakeholder engagement and iterative synthesis, balancing national diversity with transnational coherence (Firus *et al.*, 2024). Building from earlier experiences (Bartke *et al.*, 2018), this flexible yet structured method aimed to ensure inclusivity while resulting in actionable knowledge. However, several limitations of the method should be acknowledged. Due to resource constraints, the number of participants was kept relatively low, potentially limiting the breadth of expertise and increasing the risk of uneven thematic or sectoral representation within the national cases. The time allocated for

discussing SPPI in the interviews and workshops was limited, which may have resulted in omissions or superficial treatments of certain issues. Variations in the expertise and disciplinary backgrounds of the national teams conducting the initial analysis introduced potential risk for interpretative differences. Consequently, this study relies on qualitative interpretation and iterative consensus building and validation among authors. Furthermore, the primary data for this analysis are drawn from the findings documented in Maring *et al.* (2025), without conducting further analysis of the underlying data, which are reported in national languages. Translation from national languages to English also presented a potential source of error; national language executive summaries were provided with each final national report in English to ensure accurate conveyance of key messages. Finally, while the results reflect a variety of contexts, they are inherently limited by a focus on European perspectives, primarily representing high-income European contexts.

This study is structured as follows. The following section summarises the results, presents illustrative examples and discusses the success factors and challenges of SPPI in Europe. Based on qualitative content analysis, we highlight (1) approaches adopted, (2) resources and their use, (3) organisational structures, (4) policy contexts, and (5) inter- and transdisciplinary practices. The results are then examined through the lens of inclusive participation, highlighting the need for a more comprehensive understanding of inclusiveness within interaction and communication processes (Kalliomäki *et al.*, 2024; Kalliomäki *et al.*, 2025; Kunttu & Lyytimäki, 2025; Lawson, 2010; Moulaert *et al.*, 2013). Using relational trust building, equitable participation, and inclusiveness as key criteria, we propose practical steps for SPPI supporting sustainability transition. Finally, concluding recommendations are provided to support the formulation and implementation of a transnational strategic research and innovation agenda designed to support SPPI capable of addressing key sustainability challenges and opportunities. Key criteria for outlining the recommendations based on the lessons learned from the European cases include long-term societal impact of SPPI, capability to address multi-faceted challenges, and effectiveness on targeting and engaging different target groups. These recommendations are guided by the lessons learned from our European cases, emphasizing the long-term societal impact of SPPI, the ability to address multifaceted challenges, and the effectiveness of targeting and engaging diverse stakeholder groups.

Results and findings: Identifying key European SPPI challenges

A variety of tools and SPPI approaches already in use Together with earlier studies (Davies *et al.*, 2021; Gluckman *et al.*, 2021; Lyytimäki *et al.*, 2013; Topp *et al.*, 2018; Trench & Miller, 2012), our cases demonstrate a wide range of communication and interaction approaches and methods are already being utilised in Europe (Table 1). Variations were found between countries, reflecting differing socio-cultural contexts, policy systems, economic conditions, geographical settings, and institutional arrangements. Differences also appear within individual countries, where some policy domains rely on

Table 1. European examples of different SPPI approaches and tools already operational (Data source: [Maring et al., 2025](#)).

Key elements	Continuums of types of activities	Examples mentioned by the respondents
Information sharing	One-way tools for informing ↕ Two-way approaches for co-creation	Policy briefs; Websites; Open databases; Newsletters; Press releases ↕ Knowledge co-design workshops; Participatory citizen assemblages
Science advice mechanisms	Permanent science advice bodies ↕ Ad-hoc or temporary activities	Advisory councils; Science panels; Innovation policy coordination offices; Regional science hubs ↕ Events and campaigns; Science festivals; Thematic days; Awards
Context-specificity	Highly personalised and targeted approaches ↕ Generic communication for wide audiences	Science advisers and ambassadors, One-to-one discussions, Education and training of researchers and policy makers, Policy co-design workshops ↕ Media coverage and interviews, Websites
Science-policy emphasis	Research-driven approaches ↕ Policy-driven approaches	Permanent research centres and technology transfer offices, National institutes ↕ Consultants, Public relations firms, Governmental science advisors or units, Science sparring processes
ES R&I steering influencing SPPI	Specific and formal governmental policies ↕ Generic societal pressures	National and EU level strategies, Government Science-Technology-Innovation (STI) programmes, Official policies, Mission statements ↕ Stakeholder pressure, Public interest, Expectations for economic, environmental or social gains

traditional communicative tools and well-established practices, while others are actively experimenting and adapting to social and technological developments. [Table 1](#) outlines a synthesis of the key elements of SPPI presenting examples provided by the respondents through simplified dichotomous continuums.

Various national information sharing platforms facilitate collaboration between scientists, policymakers, and practitioners. Science-driven information sharing was frequently reported and increased activity within the communication departments of research institutions and universities was observed. These efforts often represent science public relations—a traditional, one-way dissemination strategy aimed at presenting and popularising research results. In a contested communication environment this approach faces increasing risks, particularly concerning trust-building between different actors ([Weingart & Guenther, 2016](#)). In some cases, communication and interaction were integrated from the outset of the research process to foster genuine engagement and more effective outreach. For example, the Strategic Research Council of Finland requires funding applicants for multi-year, cross-disciplinary research consortiums to present a detailed communication and interaction plan. The Council also encourages stakeholder interaction already during the initial outlining of research tasks.

Well-established science advice mechanisms include advisory councils or dedicated offices or units within government bodies,

responsible for summarising, analysing, and presenting evidence tailored to policy needs. National science panels, composed of prominent scholars, were also noted by respondents. These bodies are typically mandated to operate independently, as their credibility relies on their ability to provide impartial advice to policymakers. Some evidence of collaboration between national science panels and international panels, such as the Intergovernmental Panel on Climate Change (IPCC) and Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), emerged. Collaboration between science panels at the European level was not mentioned, despite the existence of networks designed to support such collaboration, such as the European Environment and Sustainable Development Advisory Councils Network (EEAC). Consequently, there appears to be an opportunity to mobilise existing actors through a ‘network-of-networks’ approach ([Kelemen et al., 2021](#)).

Context specific instruments designed to facilitate learning through dialogue include various networks, individual actors, and institutions. An example from Flanders is the ‘science ambassador’ role, which includes a dedicated training programme focusing on the circular economy. Thematic multi-stakeholder networks or platforms were frequently highlighted, particularly from a technology and business standpoint. For example, triple or quadruple helix spearhead clusters for innovation have been proposed as approaches suitable for more

wide-ranging SPPI. These approaches aim to foster dialogue between industry, knowledge providers, authorities, policy-makers, and societal stakeholders, including non-governmental organisations (González-Martínez *et al.*, 2025). Even unidirectional communication tools can be used to initiate interactive and co-creative dialogues. An example from Switzerland demonstrated how multiple non-governmental organisations can be involved to develop a policy brief, while an example from Finland highlighted the use of a concise science-based policy brief to stimulate interest among key policymakers, which led to in-depth face-to-face discussions on the recommendations presented.

Media and social media were considered both factors within the context of SPPI and tools for its implementation. The potentially divisive and polarising nature of social media was noted, alongside its potential for information sharing and targeted discussions. Press releases and media coverage are important for information sharing and public awareness, but the role of media and journalists was mentioned only occasionally. It was noteworthy that science journalism was not frequently mentioned, despite its traditionally important role in shaping the environmental and sustainability agenda (Godemann & Michelsen, 2011; Sachsman & Myer Valenti, 2020).

SPPI can also be outsourced to consultants, public relations firms, or knowledge brokers. Concerns were raised about the use of consultants in some countries (France, Slovakia), as this practice can create vulnerabilities to lobbying influence, lead to the outsourcing of knowledge generation and diminish understanding of the issues among administration and decision-makers.

Developing interpersonal skills and sustaining motivation for interaction emerged as important factors from multiple perspectives. Depending on the context, communication based on personal relationships was viewed either as a means for effective interaction (Germany, Switzerland) or as an indication of dysfunctional institutional communication (Slovakia). Researchers often lack incentives for outreach, and policy-makers often face time and capacity constraints in addressing complex sustainability issues. A lack of science literacy also emerged as a key concern, particularly for complex issues with relatively low public and policy attention, as demonstrated by the emphasis on 'soil literacy' as one of the main objectives of the European mission on soil (EC, 2021).

Concerns were raised about disinterest and even reluctance to adopt science-based recommendations among some policy-makers. This can be linked to a lack of public trust in science in some cases. In France, disinterest or distrust towards environmental and sustainability studies among certain end-users was noted. Targeted training and education to support systematic collaboration were suggested as beneficial, particularly in fostering collaboration and building trust between (early career) researchers and policymakers.

Availability and coordination of resources for SPPI

The level of funding and resources available, the degree of institutional support and coordination, and the perceived effectiveness of current SPPI practices varied considerably. Countries such as Switzerland, Wales, and Ireland exhibited comparatively established practices for communicating with policymakers across a range of channels. In France, research and SPPI benefits from considerable government funding. Flinders also demonstrated a robust SPPI framework, with numerous concertation structures, information platforms, research initiatives, and related events. In Ireland, a significant number of government agencies and departments offer competitive R&I funding in the areas of climate, the environment, and sustainability.

Conversely, insufficient or even lacking funding for SPPI remains a significant challenge, particularly in smaller countries with fewer resources. National funding schemes in Slovakia are relatively small compared to EU and international initiatives. Bulgaria faces primary challenges in developing research infrastructure. Consequently, SPPI may not be prioritised within the research process.

However, even when resources are available, the use of those resources and competencies for coordination may present a more pressing issue (Juhász *et al.*, 2024; Kelemen *et al.*, 2021). In some cases, limitations with the rules and formats of funding can hinder efficient SPPI. While some countries possess robust funding systems, inefficiencies, bureaucratic processes, and complex regulations can impede the effective use of available resources. In Switzerland, a key challenge lies in strategically aligning different funding instruments. The issue is not necessarily a lack of funding, but rather a duplication or even muddling of efforts across specific areas.

Respondents frequently highlighted a lack of long-term, dedicated funding for SPPI. Funding often focuses on specific, narrowly defined areas, or is provided sporadically for short-term projects or experiments. These funding structures often determine the degree to which actionable science can be produced, echoing recent findings that long-term, flexible funding is crucial to bridge the knowledge-action gap (Nyboer *et al.*, 2021). Therefore, this poses a particular challenge for SPPI addressing broad, long-term environmental protection and sustainability transformation. Boundary organizations, which facilitate knowledge exchange between science and policy, were particularly identified as underfunded. Although R&I should remain politically independent, political support and commitment are very important, to ensure sufficient attention for SPPI. This demonstrates how vulnerable SPPI can be to political shifts, as evidenced by Finland's experience in 2023, when the right-wing government abolished its system for inter-ministerial analysis, assessment, and research activities.

Potential avenues for supplementing inadequate national public funding included public-private partnerships and crowdfunding.

However, these approaches present challenges in smaller market areas with limited populations and risk SPPI becoming overly influenced by commercial interests and focusing on issues with high public appeal. EU funding and international grants were also considered potential sources of additional funding for SPPI.

Siloed structures and compartmentalization hinder SPPI

Fragmented organizational structures and a project-based working culture were identified as significant barriers to effective SPPI. Funding schemes and SPPI practices are frequently compartmentalized within siloed structures. As noted by earlier research (Munck af Rosenschöld, 2023), this may result in individual projects that often fail to encompass the broader scope of sustainability. Such structures and the fragmented governance landscape remain significant challenges but also reveal spaces where institutional entrepreneurs within the public sector can mobilise networks and lead by example (Alexandrescu *et al.*, 2014). Yet, overly strict compartmentalization within science can lead to inefficient resource allocation in SPPI, potential knowledge gaps, and a limited exchange with policymakers. Similarly, compartmentalized structures within government agencies were observed to impede collaboration with the scientific community, highlighting the importance of increased dialogue. Finland and the Netherlands were cited as examples of countries with relatively flat hierarchies, which can facilitate communication across administrative silos.

SPPI tools and initiatives are often implemented temporarily as part of short-term projects, dependent on fluctuating funding availability, public interest, or shifting policy priorities. This short-term focus introduces discontinuity and imposes time constraints on collaboration across all levels, from knowledge generators to end-users. Rapidly evolving R&I priorities, combined with the demands of media and social media, place considerable pressure on the speed of knowledge dissemination, exacerbating existing time limitations. This can also detract from the development of a fundamental and strategic knowledge base as resources are directed towards addressing immediate concerns. These factors contribute to difficulties in achieving coherent SPPI and underscore the need for improved coordination among ongoing projects.

Respondents from multiple countries observed that fragmented organizational structures and divergent administrative practices result in inefficient resource allocation. Facilitating personnel transfers between sectors could contribute to improved integration. Initiatives that actively convene researchers, businesses, and policymakers are essential. The establishment of boundary organizations or knowledge ecosystems to connect projects and overcome siloed approaches was consistently highlighted. Ultimately, respondents stressed the necessity for enhanced coordination of R&I initiatives to generate more systemic knowledge and drive transformative change. For example,

Slovakia underscored the importance of cross-disciplinary research approaches. Findings and methodologies from one research area should be systematically applied to others.

Different policy contexts for SPPI

Ensuring that research outcomes are readily applicable and genuinely useful within specific local contexts was emphasised as a basic function for SPPI. Current capacities to utilise SPPI differ considerably. As highlighted in Flanders, SPPI addresses a diverse spectrum of needs among various stakeholders, encompassing policy support, technological development, heightened citizen awareness, societal acceptance, resources for demonstration and implementation, robust monitoring methodologies, and a deeper understanding of human behaviour. Conversely, in Italy, research outcomes remain underutilised, risking remaining purely theoretical. A significant challenge in Italy is the difficulty faced by the nation's extensive network of small and medium-sized enterprises (SMEs)—a defining feature of the productive sector—in accessing R&I, hindering their progress towards green, energy, digital, and technological transitions. Similarly, in Austria the need to redefine the role of SMEs within R&I activities was highlighted.

The diversity of national contexts and policy systems influencing SPPI presents a significant obstacle to the development of recommendations applicable across Europe. Overly centralised systems can impede effective engagement by failing to account for local contexts and regional requirements, as observed in France. The federal structure of Germany was noted as a source of complexity in coordinating diverse regional interests and ensuring equitable representation. Regional and linguistic diversity complicates policy coordination and communication, as evidenced by the experience of the Basque Country. Bureaucratic processes can impede the translation of scientific research into actionable policies, thereby affecting implementation, as highlighted by observations from Italy.

The diversity of policy contexts also presents unique national approaches for SPPI. For example, Wales possesses a distinct legislative framework through its Well-being of Future Generations Act (2015) and Environment (Wales) Act (2016), the first of their kind to legally incorporate the UN Sustainable Development Goals. This framework mandates a joined-up approach across the public sector and requires the Sustainable Management of Natural Resources, thereby embedding an integrated consideration of environmental, social, and economic well-being into all levels of policy and practice. This provides a strong, legally-backed context for SPPI that differs significantly from other regions.

The significance of established knowledge producers—including universities, research institutions, governmental advisory bodies, and expert councils—was consistently highlighted. These organizations typically provide expert knowledge to inform policy formulation. The influence of such bodies is contingent

upon the prevailing policy environment. In Ireland, the Environmental Protection Agency (EPA) Research Programme coordinates national environmental research initiatives through the National Environmental Research Coordination Group. Every three years, the EPA conducts a comprehensive assessment to determine thematic research priorities. This process facilitates the long-term strategic development of SPPI by ensuring alignment between research and policy objectives.

However, established knowledge infrastructures also present a risk of exacerbating bureaucracy and administrative complexity, potentially hindering access to funding, project implementation, and effective communication. This risk was noted in relation to both European-level funding and within countries like Italy. Therefore, ensuring streamlined and accessible processes is vital, particularly for new entrants to SPPI, to foster broad and effective participation.

The challenge of transformative transdisciplinarity

Across the surveyed countries, the need for more diverse and interactive communication to foster transformative collaboration—research intrinsically linked to societal change—at local, national, and international levels was frequently emphasized. In Switzerland, it was observed that funding mechanisms should be better aligned with transformative research by fostering unconventional forms of scientific collaboration, experimentation, and outputs. However, the continued need for conventional, unidirectional science communication was also acknowledged. This underscores the necessity to utilize the diverse tools of SPPI through the integration of complementary approaches.

Addressing complex sustainability challenges undeniably requires the inclusion of diverse fields of expertise (Godemann & Michelsen, 2011). However, effectively bringing these disciplines together necessitates significant effort in cultivating mutual understanding and establishing effective modes of collaboration between fields of natural sciences, the humanities and social sciences, each with its own inherent culture and methodologies. Beyond interdisciplinarity, there is a growing need for transdisciplinary collaboration, which explicitly involves non-scientific actors, such as citizens, policymakers, and professionals from the productive and creative sector, media and arts.

To facilitate this, emphasis was placed on creating supportive environments that encourage dialogue and collaboration. The practical challenges associated with transdisciplinary research, particularly those involving non-scientific actors, are, however, pronounced (D'Amato *et al.*, 2025). For instance, in Italy, improved coordination of funding mechanisms alongside this dialogue was deemed essential. Similarly, in France and Austria, fostering transdisciplinarity and the collaborative construction of research with diverse actors—including citizens, associations, firms, and local authorities—was recognised as vital. Furthering this, Wales is actively engaged with international forums such as the UNESCO-Bridges Coalition, which serves as an exemplar for foregrounding the humanities and social sciences in developing solutions to the climate and

nature crises, reinforcing the need for truly transdisciplinary approaches.

Towards more inclusive SPPI

A recurring theme emerging from the European experiences was the need for more broad-based and inclusive SPPI, facilitating a just transition towards sustainability. This isn't just a matter of fairness; it is essential for ensuring that transition efforts are effective, acceptable and sustainable for all. Achieving inclusivity requires specific practices and policies designed to dismantle barriers to participation amongst under-represented individuals, social groups, firms, sectors, and regions, while fostering the integration of sustainability research and entrepreneurial activities. Ultimately, the objective is to ensure equitable opportunities for all segments of society to engage with and benefit from environmental and sustainability R&I (Lähteenmäki-Smith *et al.*, 2023; Planes-Satorra & Paunov, 2017). Collaborative co-creation and co-design SPPI processes exemplify this inclusive approach, involving diverse stakeholder groups in initiatives aligned with shared interests, such as those related to urban planning tasks (Lee *et al.*, 2024) or in developing urban transformative capacity (Wolfram, 2016).

Inclusion has already been recognised as a critical dimension of R&I policy, contributing to greater equitability and sustainability by fostering the acceptance of policy missions and facilitating their implementation (UN, 2023). Effective policy action necessitates a comprehensive understanding of its potential impacts across diverse stakeholder groups, ensuring the involvement of all relevant parties throughout planning, implementation, monitoring and evaluation. It is crucial to acknowledge that incorporating all stakeholders into the decision-making process can present challenges and risks (Bogner & Dahlke, 2022). These include the possibility of premature assumptions for consensus, the risk of dominant actors unduly influencing outcomes, and the adoption of overly simplistic solutions that prove difficult to scale (Hermans *et al.*, 2011).

Therefore, careful consideration must be given to involving relevant and representative stakeholder groups and managing the process in a structured and systematic manner (Firus *et al.*, 2024). A balanced approach is needed—one that actively seeks diverse voices while remaining alert against potential pitfalls and ensuring that outcomes remain grounded in robust evidence and a clear understanding of the complexities of the transition process. Fundamentally, inclusive SPPI represents a process of fostering trust, with the assurance that equitable solutions addressing the divergent impacts of the transition process will be identified, even in a context of long-term, global environmental change.

To further assist in achieving this, Box 1. presents practical steps towards more inclusive SPPI, grounded in the principles of relational trust building, equitable participation and inclusiveness. These steps summarise key lessons from our empirical European cases and are designed to serve as an accessible and actionable blueprint adaptable to various communication contexts, with a focus on fostering lasting, impactful change towards sustainability.

Box 1. Practical steps towards inclusive SPPI supporting sustainability transition**Institutionalise SPPI platforms for trust-building**

Establish dedicated, multi-stakeholder 'Sustainability SPPI Forums' at national and sub-national levels. These Forums should prioritise the representation of marginalized communities and individuals directly impacted by sustainability transitions. Design these forums with a deliberate focus on fostering mutual understanding and trust, embedding structured facilitation methods, participatory narrative-building and transparent decision-making rules to bridge divergent perspectives and prevent elite capture. Implement independent regular monitoring and evaluation of participation and equity outcomes to ensure inclusivity and adapt Forum structures as needed.

Reframe solutions to prioritise empowerment

Organise collaborative 'Problem Definition Workshops' co-led by scientists, policymakers, and community representatives. These workshops should explicitly examine underlying power dynamics and systemic inequalities that contribute to environmental and social challenges. Frame solutions not as technical fixes or top-down regulations, but as collaboratively designed interventions that address root causes and empower communities to become active agents of change.

Increase societal relevance through localised expertise

Develop a 'Contextualization Toolkit' for SPPI, including adaptable communication strategies, facilitation techniques, and resource allocation models. This toolkit should be designed to guide practitioners in tailoring SPPI tools to specific cultural, economic, and political contexts while ensuring alignment with EU and global objectives. Invest in localised long-term, independent knowledge brokers who possess the linguistic and cultural competency and legitimacy within their communities to facilitate effective communication and build trust within diverse communities.

Address cross-systemic knowledge needs

Establish 'SPPI Innovation Networks' at the intersection of academic institutions, government agencies, and civil society organizations. These networks should be staffed by individuals trained in systems thinking, facilitation, and relational leadership – to identify leverage points for change, build cross-sectoral partnerships, and foster collaborative problem-solving. Mandate cross-sectoral rotations for staff within these networks and introduce joint training on systems thinking and relational leadership to break down internal silos and build a shared culture of collaboration.

Address coordination and funding needs

Create a 'SPPI Coordination Fund' designed to provide long-term financial and administrative support. This fund should prioritize actors and networks demonstrating commitment to equitable participation, adaptive governance, and knowledge sharing. Mandate regular peer-to-peer learning sessions within the network to promote best practices and strengthen relationships, and ensure outputs are openly shared to foster cumulative knowledge and avoid isolated experiences.

Address actionable knowledge needs

Establish 'Community Innovation Grants' specifically targeted at supporting local businesses and community organizations to co-develop and test sustainability solutions. Provide free technical assistance and mentorship to ensure they can participate effectively in R&I initiatives and develop clear feedback loops, so community insights demonstrably influence research and innovation agendas.

Summary and recommendations**Summary of key challenges of SPPI in Europe**

A transition towards sustainability demands a transnational approach, carefully balanced with local tailoring to account for diverse contexts and development pathways both across and within nations. Successfully orchestrating this transition requires inclusive SPPI to foster a shared understanding of priorities, their regional and national implications, and the capacity to translate generated knowledge into actionable solutions within specific local settings.

Our empirical analysis identified several key challenges impacting the effectiveness of SPPI. A primary concern was the fragility and fragmentation of information utilization chains or knowledge-to-action pathways, often compounded by limited resources and capacities. A lack of coordination also restricts opportunities for cross-sectoral and cross-national collaboration. Communication limitations within regulatory bodies were observed, and formalized dialogue and co-creation processes offer significant potential to improve transparency and responsiveness. Reaching and meaningfully engaging a diverse stakeholder base remains a considerable hurdle, particularly given the erosion of trust, increasing societal polarization, nationalism and populism. Moreover, scepticism surrounding scientific evidence, the proliferation of misinformation, and general disengagement from environmental and sustainability concerns pose significant threats. Overcoming these requires deliberate trust-building and consistent, far-sighted and inspiring communication strategies.

Our bottom-up method for identifying and assessing the challenges of SPPI showed that versatile tools are already in use, providing valuable opportunities to learn what works under which circumstances. However, without a systemic approach to learning and adapting these practices, European environmental and sustainability R&I risks remaining a fragmented cacophony of different voices rather than a coordinated engine for societal transformation. Strengthening SPPI in Europe necessitates a coordinated approach encompassing enhanced interdisciplinary and inclusive cross-sectoral collaboration, refined funding mechanisms, targeted capacity building, and accessible communication channels—all of which are essential to ensuring meaningful engagement between science, society, policy and practice.

Recommendations for strengthening the methods of SPPI

To overcome identified challenges and maximise the long-term societal impact of SPPI, we propose a multi-faceted approach targeting policymakers, researchers, and funders. The use of specific tools or methods of SPPI should be grounded on the following general level principles:

- Foster coordinated and endured collaboration: Policy-makers should prioritize the creation and formal support of collaborative networks encompassing government agencies, academic institutions, and third-sector organizations. These networks should be explicitly designed

to facilitate knowledge sharing and resource allocation, ensuring their longevity despite policy changes.

- Empower local stakeholders: Broad-based engagement and empowerment of local businesses and communities are vital for ensuring R&I directly addresses local needs and contributes to a just and sustainable transition. Targeted training and resource provision should facilitate meaningful citizen participation. This requires accessible funding, sustained facilitation, involving all parties with explicit inclusion of vulnerable or marginalized groups from the outset.
- Adapt to local contexts: Recognizing distinct cultural, economic and political contexts, SPPI frameworks require adaptation to reflect local realities while retaining alignment with broader EU-level objectives and relevant global discourse. Guidance and toolkits should explicitly address how to navigate these tensions rather than defaulting to a 'one-size-fits-all' approach.
- Secure dedicated SPPI funding and robust evaluation: Commit to multi-annual funding cycles, joint budgets for research–policy–practice consortia, and independent evaluation that measures both scientific outputs and societal impacts. Long-term funding commitments and robust evaluation methodologies are essential to ensure project continuity and assess the wide-ranging societal impacts of environmental and sustainability R&I. Joint budgets for research consortia explicitly incorporating interaction activities will ensure a consistent focus on SPPI outcomes. Attracting private sector involvement and investment on environmental and sustainability R&I may alleviate financial burdens on public resources.
- Incentivise collaborative research: Realign academic incentives to actively reward cross-disciplinary, collaborative, and problem-oriented research contributions. This

should include financial and societal support for collaborations with non-academic stakeholders from the project's inception. A particular emphasis should be on developing mechanisms for small and medium sized enterprises related to environmental and sustainability R&I to participate and to test results on their own sites.

- Build societal trust and ensure transparency: Establishing permanent structures to cultivate trust and connect research outcomes with practical application is critical. Transparency means not only disclosing results but also disclosing interests and values. This requires targeted capacity building across all stakeholder groups, underpinned by open and accessible communication and interaction channels.

Ethics and consent

This study utilizes existing data that were originally collected with verbal informed consent during interviews and workshops. As the data had already been ethically approved and handled, formal ethical review and explicit consent for this secondary analysis were not required. We have adhered to principles of responsible data handling.

Data availability

This study uses data from 14 national and regional case studies as reported by [Maring *et al.* \(2025\)](#). The source materials underlying the results are openly available from: <http://hdl.handle.net/10138/596051>.

Acknowledgements

The authors wish to thank National Key Stakeholders from 14 European countries and regions for their insights and participation on CASRI interviews and workshops. Special thanks to Eeva Karjalainen, Kaisa Korhonen-Kurki, Luke Maggs.

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Open Peer Review

Current Peer Review Status:   

Version 2

Reviewer Report 22 January 2026

<https://doi.org/10.21956/openreseurope.24061.r68071>

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Bablu Kumar Dhar 

Mahidol University, Salaya, Thailand

The revision is a clear improvement in transparency and readability: the authors now state a coherent aim (mapping existing SPPI tools and drawing practical recommendations) and the expanded Background/Methods makes the overall process easier to follow and replicate in principle. The study's main value is its cross-country synthesis of "what's being used" and "what gets in the way" (resources, silos, policy context, and transdisciplinarity), and the added limitations section appropriately flags the qualitative, expert-assessment nature of the evidence and the Europe-focused scope. I have only minor remaining suggestions: (i) briefly clarify how "tools/approaches" were identified and consolidated into Table 1 (e.g., coding steps, decision rules, how duplication across countries was handled), (ii) add one or two concrete examples showing how Box 1 steps could be operationalised under different national capacity levels (high-resource vs low-resource contexts), and (iii) tighten a few repeated sentences in the Methods section to avoid redundancy. Overall, I consider the manuscript suitable as a method article and largely ready as-is, with small edits that would further strengthen reproducibility and practical uptake.

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Sustainability

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 21 January 2026

<https://doi.org/10.21956/openreseurope.24061.r68183>

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Syed Asad Abbas Bokhari 

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Summary of the Article

This method-oriented article examines how science-policy-practice interaction (SPPI) can be strengthened to support transformative sustainability research and innovation across Europe. Drawing on document analysis, semi-structured interviews, and national workshops involving approximately 300 stakeholders across fourteen European countries, the authors map existing SPPI tools and practices and identify systemic challenges that hinder effective knowledge-to-action pathways.

The study highlights persistent barriers, including fragmented institutional structures, uneven resource allocation, limited transdisciplinarity, and deficits in inclusive participation. Based on comparative synthesis, the authors propose a set of practical and institutional responses, including Sustainability SPPI Forums, contextualization toolkits, innovation networks, coordination funding mechanisms, and principles for inclusive engagement. The revised manuscript clarifies that the core contribution is methodological: it offers a structured, adaptable process for diagnosing SPPI gaps and designing context-sensitive interventions.

The second version substantially improves clarity and rigor. The aims are now explicit, the methodological workflow is transparent, sampling and participant profiles are clarified through Figure 1, links to open CASRI reports are provided, and a limitations section bounds the scope of claims. The paper now functions convincingly as both an empirical synthesis and a reusable methodological blueprint.

Review Report

- The authors have made strong progress toward transparency:
- The data generation process is clearly described.
- Interview schemes, workshop templates, and synthesis procedures are documented.
- Openly accessible CASRI reports are linked.
- The qualitative and comparative nature of the analysis is explicitly acknowledged.

However, full reproducibility in the strict sense is not possible because:

- The primary materials consist of qualitative interviews and workshops conducted in national languages.
- Raw transcripts and workshop records are not publicly available.
- The synthesis relies on interpretive and consensus-based qualitative analysis across national teams.

This is acceptable and common for large-scale qualitative and comparative studies. The revised manuscript now enables methodological replication even if data replication is not feasible. Another research team could reproduce the process in a different context using the same logic, instruments, and workflow.

Scientific Soundness

All issues that previously affected methodological clarity and reproducibility have been addressed:

- The purpose of the study is now unambiguous.
- Sampling and participant composition are transparent.
- The analytical workflow is clearly described.
- External documentation is openly linked.
- Limitations and scope conditions are explicit.

There are no remaining points that must be addressed to make the article scientifically sound. The manuscript now meets the standards for a method article in terms of rigor, transparency, and contribution.

Final Recommendations:

The revised manuscript demonstrates a clear and thoughtful response to all substantive concerns raised in the previous review round. The authors have significantly strengthened the paper's methodological transparency, conceptual clarity, and practical relevance.

In particular:

- The aims of the study are now articulated with precision, explicitly positioning the paper as a methodological and analytical blueprint for mapping and strengthening science-policy-practice interaction (SPPI).
- The Background and Methods section has been substantially expanded and now provides a coherent, step-by-step account of data generation, stakeholder recruitment, and analytical synthesis, including the introduction of Figure 1 to clarify the composition of participants.
- The authors have improved reproducibility by linking to openly accessible project reports and by detailing interview schemes, workshop structures, and the iterative synthesis process.
- A dedicated limitations discussion now acknowledges the qualitative and European scope of the study, enhancing both rigor and transparency.
- The pathway from empirical challenges to the proposed SPPI recommendations is clearer and more defensible, with explicit criteria and grounding in the collected evidence.

These revisions directly address the reviewer's concerns regarding methodological rigor, transferability, and transparency. The manuscript now functions convincingly as a method article that others can adapt in different regional and institutional contexts. The paper offers both conceptual value and concrete, operational guidance for scholars, policymakers, and research funders engaged in sustainability transitions.

The revised version meets the standards for clarity, rigor, and contribution. I therefore recommend this manuscript for acceptance without further revision.

Is the rationale for developing the new method (or application) clearly explained

Yes

Is the description of the method technically sound?

Yes

Are sufficient details provided to allow replication of the method development and its use by others?

Yes

If any results are presented, are all the source data underlying the results available to ensure full reproducibility?

Partly

Are the conclusions about the method and its performance adequately supported by the findings presented in the article?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: AI Applications in governance, sustainability, environment... Environmental sustainability, Technological innovation

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 16 January 2026

<https://doi.org/10.21956/openreseurope.24061.r68072>

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Aktham Maghyereh 

United Arab Emirates University, Al Ain, United Arab Emirates

The authors have revised the manuscript and have appropriately addressed all comments and suggestions raised in the previous review. The revisions have improved the clarity and quality of the paper, and I have no further concerns.

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1. Lyytimäki J, Kunttu L, Bartke S, Eckert K, et al.: Rethinking science-policy-practice interaction for transformative sustainability research and innovation in Europe. *Open Research Europe*. 2026; 5. [Publisher Full Text](#)

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Sustainability

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Version 1

Reviewer Report 01 December 2025

<https://doi.org/10.21956/openreseurope.23534.r64145>

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**Aktham Maghyereh**

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The article proposes a structured approach for **rethinking science-policy-practice interaction (SPPI)** to support transformative sustainability research and innovation in Europe. The authors combine insights from a large set of workshops and activities (~300 participants across 20+ European countries) with a “funnelling” analytical process to identify key challenges, gaps, and opportunities in SPPI for sustainability transitions.

They first review existing tools and approaches for SPPI (e.g., information-sharing tools, co-design workshops, science advisory bodies, campaigns and events), and then synthesize workshop results into a set of core European challenges such as resource constraints, siloed institutional structures, limited transformative transdisciplinarity, and inclusivity deficits. On this basis, they develop a set of **applied recommendations**, including institutionalised “Sustainability SPPI Forums”, contextualisation toolkits, SPPI innovation networks, and dedicated coordination funds to strengthen cross-sectoral collaboration and transformative capacity.

Comments:

1. The authors might add 1–2 sentences explicitly framing the contribution as a *methodological blueprint* (or “process model”) that other regions or programmes can adapt, to make the methodological added value even more explicit.
3. While the manuscript provides approximate numbers of participants and participating countries, the description of *sampling and coverage* would benefit from greater specificity, particularly regarding how workshops were selected, how stakeholders were recruited, and which types of organisations (academia, ministries, NGOs, industry, local authorities, etc.) were represented or under-represented. In addition, the *analytical procedure* requires clearer methodological transparency: although the paper notes that workshop outputs were “compiled into internal comprehensive reviews and synthesised into a single, openly available report,” a concise, step-by-step account of how data were coded, clustered, and synthesised (e.g., thematic analysis, iterative coding cycles, inter-author validation) would significantly improve reproducibility. Finally, while the proposed SPPI interventions—such as Sustainability SPPI Forums, the Contextualisation Toolkit, SPPI Innovation Networks, and the Coordination Fund—are well-articulated, the *criteria for moving from identified challenges to these specific recommendations* should be more explicitly described, including considerations such as feasibility, scalability, institutional suitability, and equity. This additional detail would help readers understand the rationale behind the design choices and strengthen the methodological contribution of the paper.
3. Consider providing, as supplementary material or in a repository, (i) sample workshop agendas, (ii) data extraction templates, and (iii) a schematic of the coding/synthesis workflow. This would significantly enhance reusability of the method.

4. For strict replication of the method, the manuscript would benefit from additional operational detail. Specifically, providing examples of the workshop guides, question prompts, or facilitation protocols used to elicit SPPI challenges and opportunities would greatly clarify how the sessions were structured. A brief description of how participant feedback was recorded and aggregated—whether through written notes, online collaboration tools, standardized templates, or other documentation procedures—would also enhance transparency. Furthermore, it would be helpful to explain how divergent or conflicting views across countries were managed during the synthesis stage, including whether disagreements were reconciled through consensus building, weighting procedures, or iterative validation among authors. Incorporating these details would substantially strengthen the reproducibility and methodological rigor of the study.
5. It would be helpful to clearly link to that report (and, if possible, to annexes or summaries from the workshops) and to specify what materials are publicly accessible versus internal. This is especially relevant because the paper is positioned as a method article.
6. To strengthen the link between the method's performance and the conclusions drawn, the manuscript would benefit from a more explicit reflection on what aspects of the process worked effectively and which proved more challenging. For instance, identifying which SPPI tools or workshop formats generated the most meaningful insights, where participation remained narrow or uneven, or where translation of workshop outputs into policy recommendations was difficult would help readers better understand the practical strengths and limitations of the approach. Additionally, incorporating a brief subsection on limitations and transferability, discussing the extent to which the findings are context (dependent and which components of the method may require adaptation in non-European or less-resourced settings) would add nuance and broaden the relevance of the study. Such reflections would more clearly articulate the method's applicability and boundaries, thereby enhancing both its credibility and utility for future SPPI initiatives.

Is the rationale for developing the new method (or application) clearly explained

Yes

Is the description of the method technically sound?

Yes

Are sufficient details provided to allow replication of the method development and its use by others?

Partly

If any results are presented, are all the source data underlying the results available to ensure full reproducibility?

No source data required

Are the conclusions about the method and its performance adequately supported by the findings presented in the article?

Partly

Competing Interests: No competing interests were disclosed.**Reviewer Expertise:** Sustainability

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 15 Dec 2025

Jari Lyytimäki

Thank you for the insightful and constructive review. We have revised the manuscript based on the advice. The revisions include several additions and clarifications addressing the review comments.

Furthermore, some overlapping or wordy expressions have been removed or shortened to keep the manuscript concise. Please find point-by-point responses below.

1. Response: As rightly pointed out, the aim of the study should have been more clearly stated. We have reformulated the aims statement in the second-to-last paragraph of the introduction, clearly stating our focus on mapping the tools and methods of SPPI and making recommendations based on the analysis.

2. Response: More detailed information on the sampling strategy, recruitment, and background of the interviewees is now provided, including the new Fig. 1 summarizing the roles, organizational background, and expertise of the respondents. A description of the steps of data generation and analysis has been added. Links to openly accessible reports providing detailed descriptions of the research process are also provided to enhance transparency. It is now declared that our analysis relied on qualitative expert assessment, which was considered suitable for a comparative case study approach integrating a variety of different national contexts. The criteria for moving from identified challenges to recommendations are also outlined at the end of the section on Background and Methods, emphasizing the long-term societal impact of SPPI, the ability to address multifaceted challenges, and the effectiveness of targeting and engaging diverse stakeholder groups as key criteria.

3. Response: Concise descriptions of the organization of data collection and processing are now added to the text. Links to the open-access report appendices presenting the detailed workshop agendas/structures and semi-structured interview scheme are provided. Our reliance on qualitative interpretations as a method to synthesize insights from different cases is clearly stated as part of the comparative case study approach.

4. Response: In order to ensure the transparency and replicability of the research process, essential elements of the interview scheme and descriptions of desktop studies and workshops are now added. References to the rather lengthy and detailed documentation are provided. Our synthesis relied on qualitative interpretations and iterative consensus building and validation among authors. This is now outlined at the end of the section describing the Background and Methods.

5. Response: References to the open-access reports (with annexes) outlining the methods for data generation and presenting the results serving as a basis of this analysis are now

provided more carefully.

6. Response: As we have now clarified, the main aim of this manuscript was not to develop a new method for assessing SPPI but to map the use of SPPI tools and methods and make recommendations from the perspective of sustainability transition. A paragraph focusing specifically on the limitations of this study is added to the end of the Background and Methods section. We also highlight that the focus here is on European experiences. Even though we hope that our recommendations are widely applicable, we feel that evaluating their usefulness beyond European contexts is beyond the remit of our current manuscript.

Competing Interests: No competing interests were disclosed.

Reviewer Report 27 November 2025

<https://doi.org/10.21956/openreseurope.23534.r64142>

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Bablu Kumar Dhar

Mahidol University, Salaya, Thailand

The manuscript offers rich empirical insights, but to fully meet the expectations of a Method Article the methodological contribution needs to be made more explicit and operational. I encourage the authors to clearly articulate in the introduction and Background and methods sections how their approach improves upon or differs from existing SPPI and transdisciplinary methods (e.g. in terms of scope, scale, governance and the funnelling approach), and to consider adding a visual representation of the methodological steps and data flows. For replication, the methods section would benefit from more operational detail, including the sampling strategy for interviewees and workshop participants (with sectoral and, where possible, gender considerations), the core elements of the interview guide and workshop design, and a fuller description of the qualitative content analysis and cross-country synthesis; if space is limited, these could be provided in an appendix or supplementary material. Transparency could be strengthened by clarifying the status and handling of the underlying data (interviews, workshop notes, national reports), how they are stored and accessed, and how country-level findings were aggregated (e.g. use of a common coding framework and whether multiple authors cross-checked interpretations). A short, explicit subsection on limitations would further enhance robustness, for instance by acknowledging potential biases in expert selection, uneven sectoral coverage, differences in national implementation, language issues, and the fact that the work mainly reflects high-income European contexts. Finally, in the Summary and Recommendations, it would be helpful to distinguish more clearly between (a) empirical conclusions about the state and challenges of SPPI in Europe and (b) methodological conclusions about the proposed approach to assessing and improving SPPI, including its strengths, constraints, and recommended conditions for future use.

Is the rationale for developing the new method (or application) clearly explained

Yes

Is the description of the method technically sound?

Partly

Are sufficient details provided to allow replication of the method development and its use by others?

Partly

If any results are presented, are all the source data underlying the results available to ensure full reproducibility?

Partly

Are the conclusions about the method and its performance adequately supported by the findings presented in the article?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Sustainability

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 15 Dec 2025

Jari Lyytimäki

Thank you for the insightful and constructive review. We have revised the manuscript and made the following key changes.

The focus on reviewing SPPI methods and its aim is now clearly stated in the introduction. The section on Background and Methods has been completely rewritten, and a more detailed description of the research process has been added. Key phases of stakeholder involvement and analysis are described, taking into account space limitations. The criteria and process for identifying interviewees are now detailed. The reference to the 'funnelling approach' has been removed, as it referred to the overall project approach and was designed primarily to guide the selection of environmental and sustainability R&I topics rather than support data collection specifically focusing on SPPI. Therefore, we considered that mentioning it was not essential here. A figure summarizing the background information of the involved expert stakeholders has been added. The detailed interview scheme and guidance for workshop organization are openly available as appendices in Maring et al. (2025). This is now clearly noted, and the essential elements are briefly described. Transparency has been improved by describing the data generation process in

more detail. It is also mentioned that this research does not analyze the underlying national-level data but uses the already reported transnational results as a starting point. A paragraph on limitations has been added at the end of the section on background and methods. Finally, empirical conclusions focusing on Europe and methodological recommendations focusing on guiding principles of SPPI are now clearly distinguished in the Summary and Recommendations section.

Furthermore, we clarified that Box 1 presents our proposal on the development of SPPI methods, summarizing practice-oriented steps that serve as an accessible and actionable blueprint adaptable to various communication contexts. We hope that this clarifies that the main aim here is to map the use of SPPI tools and methods in Europe and support their development, rather than develop a new method for assessing SPPI.

Competing Interests: No competing interests were disclosed.