

# The translation of transformative policy ambitions in funding research for climate change

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This paper addresses how research and innovation (R&I) policy responds to global challenges, which demand fundamental transformations of societies and economies. The paper presents the case of a transnational, European funding call (SOLSTICE) for climate change research led by social sciences and humanities. Both the development of SOLSTICE and the research community's responses are analysed in relation to the transformative R&I policy literature, identifying potential future avenues for improving the transformative outcomes of this type of funding. The study concludes that unlocking the value of transformative R&I policy concepts and approaches depends on wide stakeholder engagement in the funding instrument design phase and an active and sustained focus on achieving societal outcomes during project implementation. In addition, barriers to the effectiveness of (European) transnational funding programmes are identified, particularly when policies target community-level socio-technical transitions to address global challenges.

**Keywords:** transformative R&I policy; research funding; socio-technical transformation; climate change; joint programming initiative.

## 1. Introduction

Research and innovation (R&I) policy has evolved in recent years towards a fundamental transformation of industrial societies and economies (Weber and Rohrer 2012). Shifting from pure economic interests and narratives of growth and competitiveness (Kallerud et al. 2013; Diercks, Larsen, and Steward 2019; Ghosh et al. 2021) towards addressing societal challenges and promoting sustainable development is considered a new paradigm (Aagaard, Norn, and Stage 2022). The complexity of these challenges has been translated into targeted policies that concentrate on specific missions supporting 'sustainable solutions' (The Lund Declaration 2009; Aagaard, Norn, and Stage 2022). In this vein, established innovation policies are complemented by new thinking and approaches to policy-making (Gassler, Polt, and Rammer 2008; Boekholt et al. 2010; Diercks, Larsen, and Steward 2019; Haddad et al. 2022) under rubrics, including mission-oriented policies (Mazzucato 2017), grand challenges, third-generation innovation policies, and transformative innovation policies (Schoot and Steinmueller 2018; Diercks, Larsen, and Steward 2019; Haddad et al. 2022).

A major driver of these relatively new approaches to R&I policy and governance is the topic of Climate Change, as defined in the Paris Agreement (UNFCCC 2015) and the United Nations Agreement on the Sustainable Development Goals (SDGs; United Nations 2015). Policy models to address the global climate crisis can be described as 'mission-oriented' because they require specific targeted actions and steps to negotiate and tackle the problem (Gassler, Polt, and Rammer 2008; Mowery, Nelson, and Martin 2010). To date, research on climate change mitigation and adaptation has been based

primarily on natural science and technological and engineering approaches and solutions (Aufvenne, Egner, and Von Elverfeldt 2014; Fazez et al. 2018). Many scientific and technological contributions to the climate change challenge exist. The question of how to implement these, and to do so in a fair and just manner, remains unresolved and requires more 'concerted effort towards learning from and through action' (Fazez et al. 2018: p. 56).

This study is situated in the arena of the design and implementation of transformative R&I policies. The paper presents a case study of a policy-making practice that strives to induce or facilitate directed societal effects in the face of the global challenge of climate change, by funding a targeted research programme. The focus is the transnational European funding Call 'Enabling Societal Transformation in the Face of Climate Change' (SOLSTICE) of the Joint Programming Initiative (JPI)<sup>1</sup> Climate (hereafter the SOLSTICE Call or SOLSTICE). As a R&I policy instrument focused on addressing one of the grand challenges of our time through socio-technical transformation, SOLSTICE can be considered and analysed as a 'new generation' policy instrument (Boekholt et al. 2010; Kuhlmann and Rip 2018; Larrue 2021; Borrás and Schwaag Serger 2022).

The paper analyses how aspects of such new generation policy thinking may contribute to improving the design and performance of future transformative funding programmes, based on lessons learned from the SOLSTICE case. Section 2 summarizes the literature on transformative R&I policies and the relevant concepts operationalized in this study. Section 3 introduces the SOLSTICE case, and Section 4 presents the methods and data sources. Results are presented in Section 5,

followed by a discussion of findings (Section 6) and conclusions (Section 7).

## 2. Previous research

There is no uniform definition of transformative innovation policies (TIPs), and the need for such uniformity is argued to be weak (Haddad et al. 2022; Ulmanen, Bergek, and Hellsmark 2022; Haddad and Bergek 2023). This allows the grouping of various related policy approaches under the term ‘transformative R&I policies’ in this paper. Transformative R&I policies describe a relatively new paradigm and are conceived as policy design frameworks that contribute to desired socio-technical system changes. Schot and Steinmueller (2018) conceptualize the ‘third frame’ in R&I policy as extending policy focus beyond inputs and actors to the ‘outcomes’ of policy interventions, explicitly seeking to modulate the direction of R&I towards environmental and societal challenges such as climate change. Starting from a specific demand (Boon and Edler 2018; Grillitsch et al. 2019 refer to ‘demand articulation’; Schwaag Serger and Palmberg 2022; Smits and Kuhlmann 2004) like climate change, these policies attempt to address pressing challenges. This instigates a certain ‘directionality’ in R&I governance and policy-making (Lindner et al. 2016; Schot and Steinmueller 2018; Diercks, Larsen, and Steward 2019; Grillitsch et al. 2019; Aagaard, Norn, and Stage 2022; Borrás and Schwaag Serger 2022; Haddad et al. 2022; Schwaag Serger and Palmberg 2022).

As societal challenges are considered uncertain, fuzzy, and complex, transformative R&I policies are characterized by attention to new ventures and new pathways for opening up spaces towards policy experimentation (Ghosh et al. 2021; Howoldt and Borrás 2023) and risk-taking (Smits and Kuhlmann 2004; Schot and Steinmueller 2018; Grillitsch et al. 2019; Ghosh et al. 2021; Borrás and Schwaag Serger 2022). To reshape systems, transformative R&I approaches are associated with a mix of policies (‘policy mix embeddedness’, Borrás and Schwaag Serger 2022) that require both horizontal inter-agency coordination and multi-level governance (MLG) processes (Haddad et al. 2022), involving local, regional, national, and transnational actors (Weber and Rohracher 2012; Rogge and Reichardt 2016; Grillitsch et al. 2019; Borrás and Schwaag Serger 2022; Schwaag Serger and Palmberg 2022).

Transformative R&I policy thinking also considers multi- and interdisciplinary approaches as indispensable for tackling the complexity of challenges such as climate change, which are viewed as transcending conventional disciplinary capacities to intervene. ‘Epistemic boundary spanning’, including between relatively distant fields such as the technical and the organizational and social sciences, is advocated (Borrás and Schwaag Serger 2022). Building on forerunners such as the ‘triple helix’ (Leydesdorff and Etzkowitz 1998) and ‘Mode 2’ (Gibbons et al. 1994) models of cross-sectoral collaboration and context-based applied knowledge production, transformative R&I policy thinking often uses the term ‘transdisciplinarity’ to refer to the involvement of diverse societal groups and actors across all phases of R&I. Collaboration with stakeholders at the very early stage of ‘problematization’, or problem definition, is considered fundamental to fomenting new demands and pathways (Boon and Edler 2018).

While policy coordination–focused approaches have been argued to involve stakeholders only at a later stage of the

process (Boni et al. 2023), bottom-up developments at the grassroots level are seen as a crucial starting point for the initiation and implementation of transformation processes (Molas-Gallart et al. 2021). The increased use of inclusive and participatory policy processes (Kuhlmann and Rip 2018; Ghosh et al. 2021; Borrás and Schwaag Serger 2022; Haddad et al. 2022; Howoldt and Borrás 2023) is interwoven with the idea that transformative R&I policies should be ‘demand driven’ (Smits and Kuhlmann 2004; Grillitsch et al. 2019; Schwaag Serger and Palmberg 2022). Defining ‘directions that are based on societal needs articulated as demand’ (Boon and Edler 2018: p. 436) enables R&I to connect to and anticipate future user needs (Weber and Rohracher 2012; Boon and Edler 2018). Involving a wide range of relevant stakeholders in the policy-design process itself enables interaction and reflexive learning, which are argued to contribute to sustainable outcomes and impacts at a societal level (Molas-Gallart et al. 2021; Rohracher, Coenen, and Kordas 2023). Deep or ‘second-order’ learning and reflexivity are also seen as crucial to enable the emergence of ‘in-the-run’ directionality in policy governance processes in particular (Smits and Kuhlmann 2004; Grillitsch et al. 2019; Ghosh et al. 2021; Molas-Gallart et al. 2021; Haddad et al. 2022; Schwaag Serger and Palmberg 2022; Rohracher, Coenen, and Kordas 2023).

The new generation of transformative R&I policies and governance approaches are also argued to require new ways of assessment and evaluation (Molas-Gallart et al. 2021; Haddad et al. 2022). Entrenched policy impact logics have been argued to not work within the complex dynamics of transformative innovation processes (Schwaag Serger and Palmberg 2022; Rohracher, Coenen, and Kordas 2023). In such contexts, a formative evaluation approach has been presented as one method that can further the adaptation of transformative policies by accompanying the entire process of multi-actor design and implementation (Molas-Gallart et al. 2021; Rohracher, Coenen, and Kordas 2023). Developing a theory of change (ToC) that focuses on defining transformative outcomes rather than outputs and impacts preserves the flexibility of, and enables meaningful design for, context-sensitive processes (Boni et al. 2023). Results suggest that required shifts in the policy discourse should be matched by changes in programme implementation and evaluation approaches (Rohracher, Coenen, and Kordas 2023).

Transformative R&I policy approaches are relatively new and emerging, and some authors have identified difficulties in their implementation, including lack or failure of demand articulation, directionality, reflexive thinking, and multi-level policy coordination (Weber and Rohracher 2012; Ghosh et al. 2021). Others point to a limited understanding of the challenges current policies should target, often resulting in conventional policy approaches (Kuhlmann and Rip 2018; Borrás and Schwaag Serger 2022). Furthermore, relatively top-down mission-oriented designs are argued to inadequately recognize or consider the specific contexts, fuzziness, and complexity of the system (Boni et al. 2023). Emerging challenges are thus a lack of understanding about precisely how the various ‘real-world’ manifestations of transformative R&I policies are implemented in specific socio-technical contexts (Diercks, Larsen and Steward 2019; Ulmanen, Bergek, and Hellsmark 2022). How policy experimentation leads to transformative change is also questioned (Schwaag Serger and Palmberg 2022). As such, it also remains unclear what would be

needed to best support such implementation processes (Ghosh et al. 2021).

In their cross-national comparative study of four Grand Challenge-oriented R&I programmes in the Nordic countries, Borrás and Schwaag Serger (2022) found that ‘while many programmes are very ambitious, policymakers might have understood “transformative” in a loose manner, designing the instruments without being properly informed by theory’ (2022: p. 1). Other authors talk about a ‘mismatch between the theoretical ambitions and the translation of these programmes into practice’ (Ulmanen, Bergek, and Hellsmark 2022: p. 2) and that these kinds of policies ‘are transformative more in their rhetoric than in their design, implementation or evaluation’ (Schwaag Serger and Palmberg 2022: p. 144). There still seems to be a ‘gap between transformative goals and their actual implementation and operationalisation’ (Rohracher, Coenen, and Kordas 2023: p. 347). These examples refer to the (trans-)national level of policy design and implementation, and as of yet, evidence on local and regional levels is scarce. One element that is consistent across the current literature is that significant gaps exist between the theoretical literature and the practices of designing, implementing, and evaluating transformative R&I policies (Schwaag Serger and Palmberg 2022: p. 181).

The contribution of this paper is to investigate precisely how the transformative character of new generation R&I policies is shaped and articulated. The paper uses SOLSTICE as a case study to map the entire process of designing and implementing a climate change funding instrument. Even though SOLSTICE has certain attributes that invoke academic transformative R&I policy thinking, it was formulated without reference to transformative innovation theory or literature. The case study thus examines how policy ambitions to generate socio-technical transformation were articulated and codified in SOLSTICE. It analyses how consonant these ambitions are with elements of the theories and concepts found in the academic literature. Rather than viewing theory and practice, policy coordination and experimentation, and top-down and bottom-up approaches as binary end points, it emphasizes the nuanced processual interplay between these concepts. In doing so, the paper also seeks to identify barriers to the design and implementation of transformative policies. By adopting a process orientation, the study thus provides insights into how R&I policies with transformative ambitions emerge and how a more theory-based and reflexive policy design process might improve and support policy outcomes.

### 3. Case study description

The transnational funding Call SOLSTICE—Enabling Societal Transformation in the Face of Climate Change—was established by the JPI ‘Connecting Climate Knowledge for Europe’ (JPI Climate). The European Commission’s Joint Programming process includes EU Member States (MS), Associated Countries, and Third Countries. On a voluntary basis, participants take part in research activities and programmes designed to tackle major societal challenges (Hunter et al. 2016). Currently, ten JPIs are working on different topics and challenges, of which climate change is one. Through the strategic development of transnational joint research agendas (hereafter Strategic Research Agendas, SRA), the JPI is one of the instruments for the realization of the European Research

Area (ERA). JPI Climate involves nineteen MS and their representatives, including ministries for science and research, academies of science, scientific institutions, and agencies. JPI Climate’s operational and programmatic activities are implemented by task forces or action groups (AGs) in consultation with its Transdisciplinary Advisory Board (TAB) and then approved by the Governing Board.<sup>2</sup>

The action group ‘Enabling Societal Transformation’ (AG EST) initiated the SOLSTICE Call. Based on a previous call for transnational collaborative research projects in 2013<sup>3</sup> and a White Paper (West and Worliczek 2019), AG EST co-created SOLSTICE with scientific and policy stakeholders from participating countries.<sup>4</sup> SOLSTICE aimed to generate knowledge and expertise that will impact society and policy by enabling transformation in the face of climate change. SOLSTICE specified that ‘novel interdisciplinary collaborations across social sciences and humanities and potentially beyond are required’ (Call Secretariat 2019a), with social science and humanities (SSH) leadership of applicant consortia a mandatory requirement. Transdisciplinarity was also promoted, through the ‘engagement of societal actors in co-design and co-production...where appropriate’ (Call Secretariat 2019a). Launched in autumn 2019 and closed in February 2020, the Call followed a ‘1.5-stage deadline model’ that required applicants to submit an outline proposal for approval prior to a full submission (Göd et al. 2022).<sup>5</sup> In the end, seven projects received funding, to begin in spring 2021 and expected to end in winter 2023.<sup>6</sup>

### 4. Methods and data

This paper reports on a single, qualitative case study (Yin 2003) that combines traditional research methods with elements of a formative evaluation approach and a process evaluation strategy (Patton 1980). The case study is based on an information-oriented selection (George and Bennett 2005; Flyvbjerg 2006) building on knowledge of SOLSTICE and anticipated access to participants, stakeholders, and documents. Case studies have a distinct role in evaluation research (Yin 2003), and participatory and mixed-methods approaches have proven to be appropriate for assessing interdisciplinarity and knowledge translation between different levels of actors and spheres (Roelofs et al. 2019). A formative evaluation approach can entail co-creational components, comprise transformative innovation principles, and is suitable for different contexts (Molas-Gallart et al. 2021).

The longitudinal approach enabled the researcher to accompany a substantial proportion of the implementation of SOLSTICE. Research activities commenced shortly after the funding decision had been made (October 2020), but prior to the successful projects starting. Research activities continued until the original planned finish date for the projects (December 2023). Figure 1 shows the different methods and data used in this study. A process tracing method (George and Bennett 2005) commenced with the SOLSTICE design phase and continued until the mid-point of project implementation (the dashed lines in Fig. 1) and the preparation of this manuscript. A process-oriented approach was similarly applied to transformative innovation policies by Kroll (2019), who also emphasized the importance of the concept of translation to understand how strategic ambitions become concrete

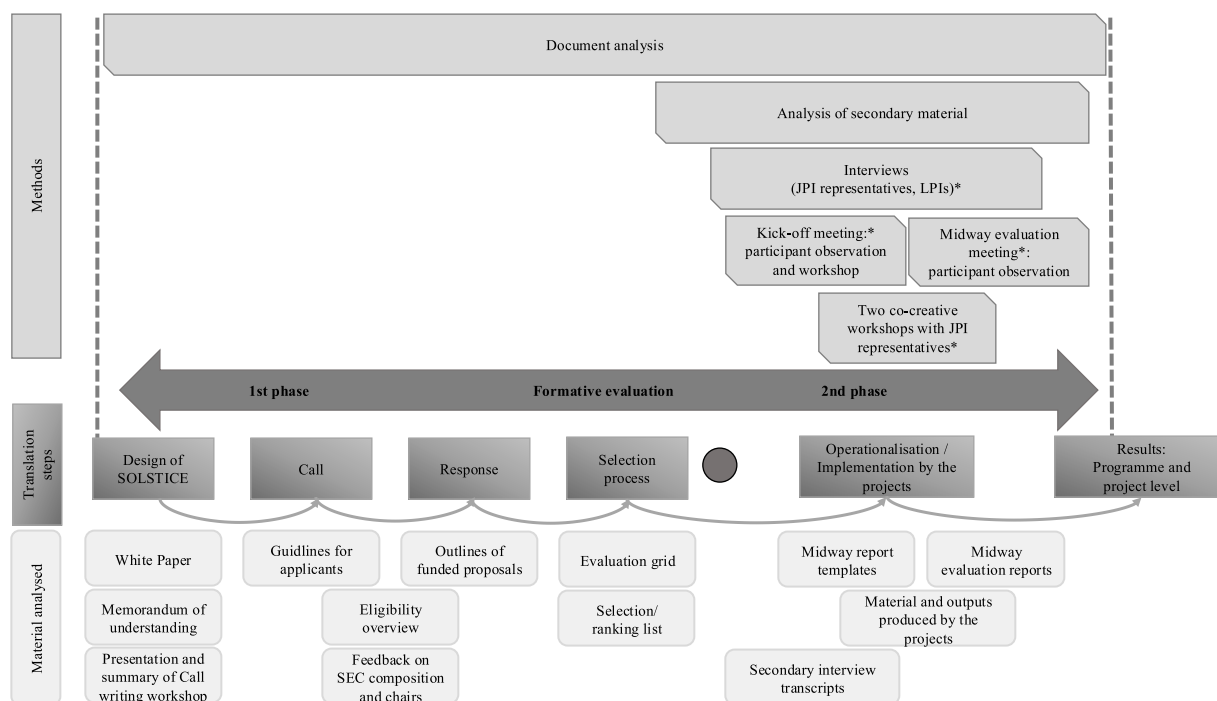


Figure 1. Formative evaluation research approach\*.

\*Translation steps (shaded grey), material produced in the process of implementing SOLSTICE and gathered and analysed in the evaluation (light grey), research methods (grey). The circle marks the point at which the author entered the process.

policy measures. Process tracing identified a series of translations from the design of the Call, to the scientific community’s response, to the initial phases of the funded projects. The projects are ongoing at the time of writing, and as such, their full results, outcomes, and contributions to societal impacts are beyond the scope of this paper.

As the author entered the process after the funding decision, information on the development of the Call, the Call writing workshop, and the selection of projects was gathered from analysis of secondary sources (Table 1), and exploratory interviews (Table 2). This marked the first research phase of the formative evaluation (Table 2). A review of the materials used to develop SOLSTICE provided initial insights into the policy design phase. In a parallel step, content analysis served to map the stated goals, objectives, and research content of each project proposal. Analysis of the proposals identified the (often implicit) anticipated project outcomes and the planned approaches for outreach activities designed to contribute to societal impacts. Together, these elements allowed for an understanding of how the research community responded to the transformative aims of the Call.

In addition, data were accessed from interviews ( $n = 17$ ) conducted as part of a concurrent Master’s (MSc) degree project (funded by JPI and not related to the formative evaluation). Sharing of these data between the MSc research and the formative evaluation was indicated in the informed consent forms and processes with interviewees. Transcripts and preliminary summaries were made available confidentially to the author. Informal interviews and discussions of the preliminary results with the interviewer and JPI representatives were also part of data collection and served as a source of background learning and cross-validation. Data drawn from these multiple sources were analysed to identify prominent themes

Table 1. Secondary sources included in the analysis.

| Publicly available   | Confidential   |
|--|--|
| White paper  | SOLSTICE Memorandum of Understanding                   |
| Call guidelines for applicants   | Presentation for Call writing workshop                 |
| Factsheets on funded projects  | Summary of Call writing workshop                       |
| Scientific outputs produced by the projects (including websites, factsheets, publications, etc.) | Contact lists for participants in the SOLSTICE process |
|  | List and feedback on SEC composition and chairs        |
|  | Evaluation Grid  |
|  | SOLSTICE eligibility overview                          |
|  | Evaluation ranking list                                |
|  | Secondary interview transcripts ( $n = 17$ )           |
|  | Midway report templates from earlier projects          |

that served as topics and prompts in the subsequent empirical phase.

The research initially explored the extent to which SOLSTICE was theory-driven in its design and development. Adapted to the outcome of this phase, a ToC was then co-created with JPI Climate to capture stakeholder expectations and used as a methodological tool to clarify the implicit logic of the SOLSTICE design. Two workshops (one online, one in-person) were held with JPI representatives, which served two main purposes. First, preliminary results were presented regarding assessment of the first translation steps. Second, joint learning and reflection involving the researcher and those responsible for JPI Climate helped establish a shared

**Table 2.** Timeline of research activities.

| Research activity   | Timeline                              |
|---|---------------------------------------|
| Analysis of secondary documents and other sources<br>Exploratory interviews ( $n = 2$ ) with representatives from JPI Climate<br>Participation and organization of a workshop session at the kick-off meeting<br>Analysis of secondary interviews ( $n = 17$ )<br>First formative evaluation co-creation workshop (online) with JPI Climate representatives   | Research phase 1<br>(10/2020–04/2021) |
| Second formative evaluation co-creation workshop (in person) with JPI Climate representatives<br>Interviews ( $n = 11$ ) with LPIs and representatives of JPI involved in the design and implementation of the Call and evaluation of projects<br>Analysis of written mid-term evaluation reports provided by funded projects<br>Participation at mid-term meeting and presentation of interim results of the formative evaluation<br>Analysis of project outputs | Research phase 2<br>(05/2022–11/2022) |

understanding of the history, objectives, and evolution of SOLSTICE. In these workshops, ideas and concepts from transformative R&I policy thinking (Section 2) were also introduced and discussed with representatives of JPI Climate. The aim was to share some conceptual ideas on transformative policies and explain how the evaluation team would use them to interpret the funding process and its implementation.

In the second empirical phase (Table 2), interviews were conducted with people involved in the development of the Call, the proposal evaluation procedure, and the development and implementation of funded proposals (researchers). Interviewees included three representatives from JPI and all seven lead principal investigators (LPIs) from the funded projects. All interviews were recorded and transcribed by the author.

The formative evaluation involved close collaboration and interaction with JPI representatives throughout the entire process. Research included invited participation in official and closed events and the development of additional activities involving the researcher and JPI representatives. Participation in meetings with JPI ( $n = 16$ ) included the SOLSTICE Kick-off, which contained a participative workshop session led by the author and joining the Interim Evaluation meeting organized by JPI. The latter involved providing feedback on the preparation and process and questions for the written mid-way reporting. Documents and presentations prepared for these different purposes were shared, including a summary of the interim evaluation analysis that was presented to the JPI Climate Governing Board. These activities were not only used to continue the evaluation but also to increase the stakeholders' awareness and understanding of the different steps in the process.

The main limitation of the research approach was that the formative evaluation, originally intended to be more constant and include more co-creative activities was significantly curtailed due to time demands, leading to a somewhat more standard evaluation approach being followed. As mentioned,

the researcher's participation in the SOLSTICE process started after the successful projects were selected. Therefore, the analysis retrospectively reconstructed the design phase. Nevertheless, the research benefited from a very high degree of access and willingness to cooperate with the evaluator among all stakeholders, including both policymakers and the research community. JPI representatives demonstrated a clear interest in the research collaboration, analyses, and results, especially in relation to relevant learning for potential future funding calls. However, no access was given to unfunded proposals, meaning that a broader evaluation of the response of the research community to the transformative ambitions of SOLSTICE was not possible.

Considering the previous research outlined and the contribution this study seeks to make, this paper addresses the following research questions:

- How does SOLSTICE seek to generate socio-technical change to address climate change?
- To what extent does SOLSTICE adopt or otherwise reflect transformative R&I policy and practice?
- In the SOLSTICE case, what obstacles can be identified to the design and implementation of transformative R&I policy?

These questions are addressed through the presentation of results in Section 5, followed by discussion in Section 6.

## 5. Results—two translations

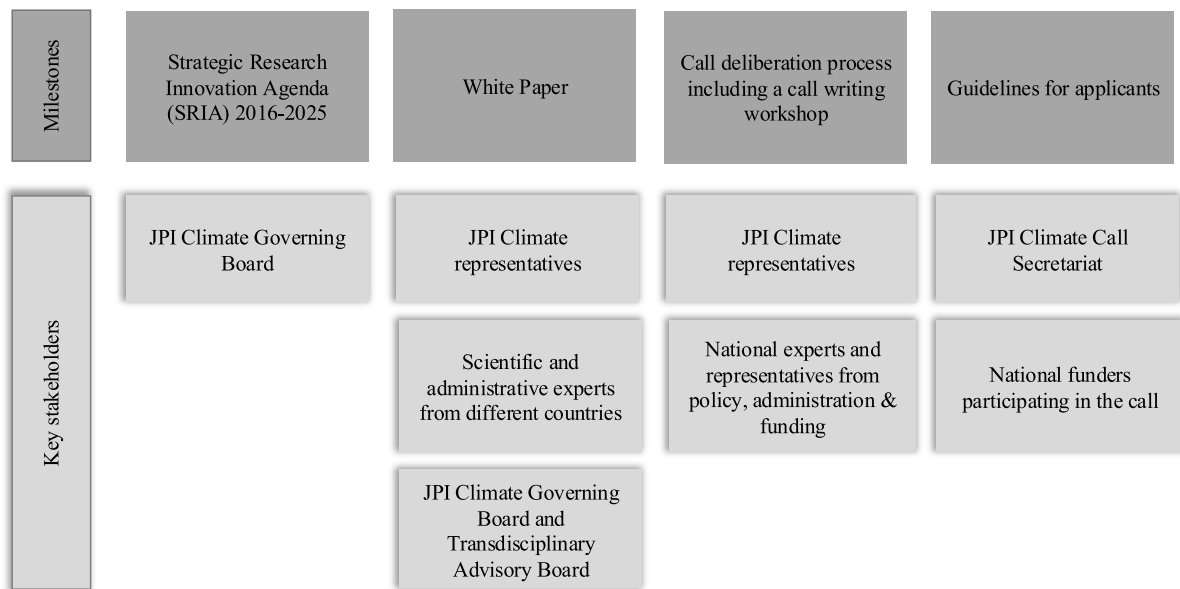
This section reports the process of designing and implementing SOLSTICE as a series of two translations. These translations move from: (1) the policy idea to the design of the SOLSTICE funding instrument; and (2) from the response of the research community to the midway evaluation of funded projects. These translations overlap but frame a relatively straightforward sequential presentation of the study results.

### 5.1 Translation 1: from policy ambition to the SOLSTICE Call

The first translation was structured by a highly participative policy formation process that included several key milestones (Fig. 2).

The seed for SOLSTICE was planted in the Strategic Research Innovation Agenda 2016–2025 (SRIA) of the JPI Climate Governing Board, which identified that 'activities explicitly addressing the social and economic sciences and the humanities are considered a gap in climate change research' (JPI Climate 2016: p 18). In 2019, the JPI EST working group initiated the development of a policy White Paper (WP) entitled 'Operationalising knowledge on and for societal transformations in the face of climate change' (West and Worliczek 2019). This process involved representatives from nine participating European countries, with inputs and advice from the JPI Climate Governing Board and Transdisciplinary Advisory Board.

The WP promoted three epistemic dimensions—(1) social sciences and humanities driven, (2) interdisciplinary, and (3) transdisciplinary research—along with preferred outcome-focused approaches to underpin a coherent policy design to fill the research gap identified. The development process of the



**Figure 2.** Key milestones and main stakeholders involved in the first translation.

WP was the result of concerted action to find ‘points of connection that all countries in Europe might have in terms of advancing a particular idea of societal transitions and transformations’ (Int\_2). This was followed up by deliberations on the Call text. Alongside JPI representatives, this included national experts and representatives from administrations, ministries, and funding agencies of countries interested in participating in the Call.

The WP placed SSH research at the centre of policy design thinking with the ‘aim to provide recommendations and insights for connecting and mobilizing key SSH research perspectives on and for societal transformations in the face of climate change’ and to ‘attract a diversity of SSH and interdisciplinary perspectives’ (West and Worliczek 2019: p 2). According to the WP, the focus on SSH should lead to new knowledge from different disciplines to solve pressing issues and lead, beyond scientific results, to actionable research that is less abstract and more practically oriented. SSH would build the bridge and be the entry point for engagement not only with societal actors but also with policy and practice. According to participants in the design of the Call, starting from this base in SSH leadership, SOLSTICE also aimed to provide a space for experimentation to avoid attracting ‘usual suspects’ and ‘reach disciplines that did not intend to apply’ (JPI Climate AG EST 2019: p. 2). This would create an opportunity to bring together new disciplines, develop new methodologies, and thus build the ground for new approaches to climate change research.

Closely connected to SSH-driven climate change research was the strong preference for interdisciplinary approaches. The assumption was that SSH *interdisciplinarity* would be necessary to address the wicked problem of climate change by ‘opening up new perspectives and understandings on the societal aspects’ (Int\_2). In the development of the Call document, SSH as an ‘innovative perspective’ was a national priority for almost all participating countries (JPI Climate AG EST 2019: p. 4). There was a sense among these actors that natural science and engineering (STEM) approaches faced challenges delivering real-world solutions, being relatively distanced

from society and focused on technical problems. At the Call Writing Workshop, this was formulated such that the SOLSTICE design should aim for a ‘Call for SSH led projects, but strongly encourage collaboration with natural sciences (sciences closer to classic climate science)’ (JPI Climate AG EST 2019: p. 2, brackets in original). Yet stakeholders involved in the design also wanted to avoid SOLSTICE becoming too ‘targeted to specific disciplines’ (JPI Climate AG EST 2019: p. 2) as this could limit the possibilities and experimentation of the project proposals produced by the research community. Finally, what was mandated in SOLSTICE was SSH leadership and ‘novel interdisciplinary collaborations across social sciences and humanities and potentially beyond’ (Call Secretariat 2019a: 5).

The third epistemic dimension that was a consistent focus across the policy design process was *transdisciplinarity*. The involvement of non-scientific stakeholders was the subject of a dedicated chapter in the White Paper entitled ‘Transdisciplinary Guidance’ (West and Worliczek 2019: p. 11), and was argued to improve the long-term impact of the projects and thus the transformation of society.

We see that politics or policies are not able today or governments are not able today to move on to a new model. So, if governments and policies are not able to do this transformation, so we can hope that citizen and social movements could be the way to transform it. (Int\_3)

Transdisciplinarity was also considered important to support the transfer of SSH knowledge beyond academic outputs.

SSH knowledge in particular can be very academic, you know. (...) When you’re talking about impact and dissemination that you have a concern for making your research, you know, transferable; if possible, less abstract, more practical and that you attempt to operationalize some of the more abstract concepts and ideas that are coming from the research. (Int\_2).

The conclusion in the WP was to ‘recommend that the JPI Climate Governing Board includes requirements for transdisciplinary research in all future calls for proposals’ (West and Worliczek 2019: p. 2). However, following deliberations with funding agencies and administrative representatives, the requirements for integrating transdisciplinarity as a mandatory funding criterion in SOLSTICE changed.

We identified transdisciplinarity as a really important component and this is where, sort of some discussion we had in terms of whether to include transdisciplinarity or interdisciplinarity, you know, and we eventually went with the interdisciplinarity, and that was more to the choice of the funders ... if we added transdisciplinarity as a criteria that would limit projects that perhaps wouldn’t have that reach or that capability to go beyond their academic sort of focus. (Int\_2).

There were concerns that obligatory involvement of social actors might limit the scientific rigour of project proposals, and ‘impose’ something unwanted on them. In addition, institutional factors were an important influence, particularly eligibility and funding conditions.

So, then countries with very strict restrictions ... where we could not make stakeholder engagement or stakeholder participation a required criteria, an eligibility criteria, for submitting your proposal. Because in countries where they have very little funding opportunities for private sector or NGO’s or whatever (Int\_4).

The final SOLSTICE Call text recommended ‘engagement with stakeholders’ to generate creative and alternative ways to achieve impacts (Call Secretariat 2019a: p. 7). However, transdisciplinarity needed only to feature where researchers considered it ‘appropriate’ (Call Secretariat 2019a: pp. 7, 10). There was no guidance in the Call on how stakeholder involvement should be operationalized or at what point in the project research cycle this would be desirable.

Policy development leading towards SOLSTICE also focused on shaping desired project outcomes. Five thematic priorities described in the WP were the product of literature reviews, and the negotiation and integration of national research priorities. Continuing deliberation across the design process eventually saw three thematic priorities appear in the final Call: (1) Social justice and participation, (2) Sense making, cultural meaning and risk perception, and (3) Transformative finance and economy. The research community was required to direct their proposals to at least one of these priorities.

Contribution to socio-technical transformation was the overall expected outcome of SOLSTICE. Initially, societal impacts were not explicitly addressed, neither in the Strategy nor in the White Paper. However, during the deliberations and across the Call development process, it was repeatedly stated that ‘special attention’ should be paid to social impact. As this did not fit into the funding schemes of all participating national funding bodies, ways were requested to give more importance to this aspect and to find alternative ways to evaluate it.

Looking for something that’s quite robust and substantial in terms of, you know, the scientific quality of the ideas

and the sort of impact that it, you know, expects to have. Because this is where we are in terms of, you know, pushing society towards or accelerating the transition processes (Int\_2).

In the end, social impact was included in the guidelines for applicants; ‘to emphasize the importance of the scientific quality and impact of the proposals, these two criteria will receive a double weight’ (Call Secretariat 2019a: 11). What was meant by ‘impact’ in terms of societal outcomes was not explicitly defined in the design phase of the WP or the guidelines for applicants. Even though the description of societal impact in the guidelines primarily focused on dissemination strategies, open access, and outreach, it was also clear that the ‘impact should not be limited to scientific publications but should have the potential to trigger change in behavior and attitudes at any level of society’ (Call Secretariat 2019a: 7). The outputs and outcomes of the proposed projects were to be described in detail, but it was not required to specify how they were to be followed up or how they could create pathways to impacts in society.

Overall, the transformative ambitions of the SOLSTICE Call were embedded in epistemic requirements and guidance, and a preference for projects to plan for social impacts. By the finalization of the Call text, some of the ideas expressed in the WP had been moderated or left aside. The decisions taken about mandated criteria and preferred approaches likely had consequences for those who responded to the Call and the form their responses took. Theory and insights from transformative R&I policies were not part of and had no influence on this translation process.

## 5.2 Translation 2: the response of the research community and the selection and implementation of funded projects

The second translation involves three main elements, the response of research communities to the published SOLSTICE Call in the form of proposals, the process of evaluation and selection of grantees, and the initial phase of implementation of the funded Projects. The results presented here are based on analysis of successful project applications, interviews with the LPI of funded Projects, analysis of the mid-term evaluation reports, and participant observation in the kick-off and mid-term evaluation meeting. The interviews focused primarily on reconstructing the period of proposal preparation and secondarily on the early phases of Project implementation.

In response to SOLSTICE, the JPI Secretariat received 96 proposal outlines, of which 72 were eligible for funding and invited to submit a full proposal. Overall, responses to the Call were heavily focused on the social justice and sense-making themes (53/72). It was a concern to JPI that relatively few responses were received for the ‘transformative finance and economy’ theme, but an explanation remains unclear.

The evaluation of full proposals was a two-stage process. First, a remote evaluation by international experts from the field and, in the second step, a panel evaluation. It was important to those responsible for the selection of the panel that, besides scientific experts, representatives from the Transdisciplinary Advisory Board were involved to assess the planned societal impact.

That there really are also one or two people in there who specifically have the aspect of impact in mind, now not so much the aspect of excellence, but really look at how is this implementable and how can this reach into society. (...) We wanted different schools of thought to be represented and [an even distribution of] gender, geography, seniority, excellence versus application. (Int\_1). [author translation]

Evaluators were provided with an 'Evaluation Grid' for use in their assessment of Project proposals. The Grid was developed by the Call Secretariat and the AG EST, with feedback from the participating countries. The Grid included *interdisciplinarity* under the assessment of 'quality and efficiency of implementation'. Evaluation criteria were mixed under this rubric, and evaluators needed to balance their assessment of the interdisciplinary combination of the consortium with their evaluation of overall workload and gender balance. It remains unclear to what extent the mix and 'distance' of the different disciplines in the submitted proposals influenced the evaluation scores received.

In relation to *transdisciplinarity*, evaluators were asked to rank proposals on a continuum. This ranged from '[t]he proposal makes no attempts to involve non-scientific stakeholders where appropriate or justify their absence', which was rated as poor, to '[t]he proposal pushes the boundaries of transdisciplinary involvement, engaging non-scientific stakeholders in a highly synergetic manner' (Call Secretariat 2019b). Inclusion of non-academic partners was not mandatory, and no funded Project involved non-scientific stakeholders in the initial problem framing and the design of the projects. From the funder's perspective, this was not only unfortunate but also understandable in part due to institutional restrictions on eligibility for funding.

[M]ost proposals were talking about stakeholder engagement, but there is still no guarantee, that they will have an impact. It is easy to say, that you will reach out, but it needs to be successful. So, I think these people should be full partners as well. (Int\_5)

As access to the unsuccessful project proposals was not possible, it remains unknown whether the combinations of disciplines and integration of transdisciplinary partners described in these proposals were similar to those of the funded consortia or not.

Seven projects were selected and received funding totalling 6.9 million euros<sup>7</sup>, with all projects beginning in spring 2021 and funded for 3 years. Two projects were funded on the topic of 'social justice and risk perception', two on 'sense making, cultural meaning and risk perception', and three combined these two topics. Country partners in funded consortia included (LPs in brackets): Austria two (one); Belgium two (one); Czech Republic two; Finland three; France three (one); Ireland one; Italy three; Norway four (two); and the UK five (two), while no Latvian partner was funded. Table 3 shows the distribution of disciplines within funded SOLSTICE Projects. A wide range of SSH disciplines are included, while the only STEM disciplines to feature were various types of civil and environmental engineering.

Representatives from the funded projects considered a funding scheme specifically focused on SSH leadership on climate change to be an opportunity. The Call was valued

**Table 3.** Distribution of disciplines in funded SOLSTICE projects.<sup>a</sup>

| Project                    | Participating disciplines  |
|----------------------------|--|
| 202 CM                     | Linguistics, anthropology, law & governance, social psychology   |
| CCC-CATAPULT               | Geography, environmental psychology, <b>environmental management</b> , social sciences, planning and urban geography, civil and environmental engineering, risk management and public and environmental policy, intercultural education (education & culture), civil and environmental engineering |
| CLEAN Cultures             | <b>Sociology</b> , environmental/social psychology, economics, process engineering and environmental science, environmental engineering and environmental economics  |
| JUST-Decarb<br>Just-Scapes | Philosophy, <b>political science</b> , economics, law <b>Environmental SSH</b> (international development), geography, psychology, political science, futures studies, creative writing  |
| ROLES <sup>b</sup>         | Economic and human geography, urban studies and regional planning, behavioural economics and public policy, science & technology studies, environmental engineering and ecological economics   |
| SOLARIS                    | Legal studies/private law, demography, geography/planning, <b>policy studies/political science</b> , water engineering, sociology  |

Source: Project proposals.

<sup>a</sup>Discipline of Lead Principal Investigator are given in bold.

<sup>b</sup>LPI is an interdisciplinary Professor working across energy, environment, and international development.

for opening this possibility, rather than the more typical orientation towards STEM in this area.

(...) especially in the field of climate, it's [funding calls] written for interdisciplinarity, but in fact, the lead partner is from ... Maths, from statistics, from biology to Earth to raw scientific fields. So, the idea that it's dedicated and leading by a social science partner was really something very interesting for us. (Int\_y3)

In their design, most Projects employ a relatively modular design, with disciplinary work distributed among the respective work packages and partners, starting with conceptual work, to empirical phases in case study formats, followed by a phase of interpretation and synthesis of the results and dissemination in the final project stage.

We can do something together, we can write together... I think that the project will have good results or... results..., even if the degree of interdisciplinarity is not so high. I think the three groups are developing interesting results. ...So I'm not an expert on that. I hope that this study day and other cooperation will develop our method and degree of interdisciplinarity. And, of course, this is a task of this last part of this year. (Int\_x4)

Most LPs had prior experience working in interdisciplinary teams and some relied on already existing contacts in assembling their consortia. During the first implementation phase, collaboration with disciplines that are relatively 'distant' was discussed as both challenging and fruitful. Some LPs reflected on the challenge of understanding the different languages of



other disciplines, increasing the time required to agree on terminologies and develop shared understandings. Over time, this became one of the essential strengths of the SOLSTICE projects, according to these Project leaders.

And we agree on many aspects of it. Well, you don't have..., we have even written down common definitions, ontological ones, syllogical ones. But we don't necessarily agree, and we don't all sign up to it. And that's useful. Because the point is not to come with a very neat definition, it is still of use that..., a helpful focal point so that we can take from it. (Int\_x2)

This approach tends to lead to individual partners working separately on different discipline-based tasks, with selective activities of collaboration and co-creation not only, but increasingly in later phases focused on integrating these distinctive contributions. As stated by one of the LPIs, this is multi-disciplinary rather than interdisciplinary work.

Overall, interviews with LPIs revealed varying degrees of experience with the involvement of non-scientific stakeholders and the design of transdisciplinary research approaches. Not including non-scientific stakeholders in the proposal design was explained pragmatically by one LPI.

Not in writing it [the proposal], because our stakeholders are people who are busy doing their own things and we don't burden them with the kinds of quite sophisticated research task of drafting a proposal in response to very specific terms of reference. (Int\_y2)

Most LPIs described the involvement of non-scientific stakeholders as challenging.

I still don't have... the receipt or the clue or the magic thing that would help the dialogue between researcher and stakeholder. ...The transformative impact of the project, at least from an implementation [point of view], a public policy implementation point of view, really needs a type of intermediation between researcher and stakeholder, that at least I don't know how to do that. And I really need somebody. A consultant. Some help, some people working with me, to help us to transduce, to translate, to organize the discussion. (Int\_x7)

Institutional complexity, including different rules on the eligibility of non-academic organizations for funding, was also perceived as a barrier from the perspective of applicants, '[t]he most challenging thing was that SOLSTICE [secretariat] was the lead, but you still had to work together with all the national funding organisations' (Int\_y6).

Perhaps unsurprisingly, given the institutional challenges to involve stakeholders in project design and problem definition as full Project partners, successful Projects concentrated on describing their *outputs* rather than their *outcomes*. In all cases, scientific articles are cited as the main output and, in some, also as outcome.

We can't guarantee it of course that someone will pay interest in our research. But I think that ... communication is a big part of that, especially if we are able to publish in good journals, that will give us the confidence that these results

are worth the reading for more people and then being able to communicate it in a form that it is interesting enough for people to actually sit down and read it and use the advice. That would be a great outcome. (Int\_x3)

A vision in the funded proposals for how the funded Projects' outputs could be mobilized for societal outcomes mainly relates to individual or workshop-based presentation of results, collection of feedback, or how further work on outputs (such as toolkits, handbooks, policy briefs, or dissemination materials like videos) could be structured and prepared from the stakeholder's perspective. A few Projects planned to move the presentation of results directly into local communities, collaborate with neighborhoods or schools and use visualization techniques to capture the interest of the population, including through the inclusion of arts-based methods or narrative work. Others refer to more traditional ideas such as soliciting feedback or disseminating information through a website or via social media to engage 'a larger public' with their results.

Challenges in designing how to deliver societal impact were also evident. Project leaders were uniformly conscious of the importance of societal impact for achieving the transformative ambitions of SOLSTICE. Two Project LPIs commented that they particularly sought to develop this aspect of their proposal. However, the Call text seemingly did not motivate an intensified effort to develop a strategy for generating societal impact pathways for the most successful consortia.

No, it doesn't really impact or influence the proposal. It's quite obvious, and it's quite normal that scientific quality and impact are strong criteria. So, they receive a double weight, and it's OK. It's not a problem for us. (Int\_y3)

Rather, the majority of LPIs regarded the double-weight placed on the combined societal impact and scientific quality as a relatively standard procedure in application processes.

By the time of the mid-term evaluation meeting, which the researcher attended, representatives of JPI and LPIs discussed together the difficulties associated with translating project objectives and activities into concrete societal impacts.

...everything that we're doing is to think about what we understand by transformative change. I mean, that's the thing. Maybe that's more... more our contribution than actually making it happen in a way. (...) It's a debate within the project, in a way, if this is transformative research or if this is research about transformation. I don't know... (Int\_x5).

Concerns about how to describe 'impact pathways' were evident in these discussions. The difficulty of assessing societal outcomes and doing so in the restricted timeframe of a research project was also a matter of concern that emerged.

...there are few immediate solutions commensurate to the scale of the problems that can be implemented for adequate societal impact within a project timescale (such as three years), so part of our hope is in situating relevant knowledge with key actors in the contexts where this can be actionable and help steer the course toward a better future. (Project mid-term report)

LPIs also referred to the ‘reality’ that follow-up regarding the use or diffusion of project outputs beyond the project was unlikely to occur.

Whilst clear strategies for generating outcomes were not clearly formulated in the proposals, in their first implementation phase, projects engaged with a variety of non-scientific actors to different extents. Interactions occurred mainly in local place-based contexts, to co-create activities that contribute to the project’s objectives. These include diverse local stakeholder groups, from everyday users of technologies to experts within different sectors, from representatives of communities to schools (teachers, youth) and policy makers. Participative, collaborative methodologies, including hands-on workshops, T-labs (transformation labs), ongoing consultation processes, and other public and closed-door events, were envisaged to contribute to societal impacts.

Project leaders conceived cooperation with more ‘practice-oriented’ partners within their consortia as helpful in this regard, particularly for presenting research outputs less abstractly to improve their relevance to societal stakeholders.

And I think that was quite helpful at the end of the day because, in order to focus on the intervention and what we want to do with the people and then really formulate more concretely and not to break down from an insanely high and abstract level then directly to the practice and what we do practically. But to have a mediation level in it, so to speak. (Int\_x1) [author translation]

Such social impact focused actions were put into practice at the Project level. However, a trade-off between the specific demands of working with non-academic partners to generate societal impacts and the typical academic (career) pressure to produce publications from the projects was perceived to exist.

I feel that they also want to change something in public policy etcetera, but at [the] least they want articles. Yeah, so the time they have obviously, it’s not dedicated to solving this second question of, of transformative impact. It’s really in their heart. It’s really in their mind. They would like to do that so much. But they are really article-oriented in their choices, in their agenda ... in the time they give to the project. (Int\_x7)

It was argued that in general, but especially for the PhD students involved in the projects, it is important to publish *within* the project duration—and not to wait until all the results from the projects are available or the projects have ended.

Finally, during this phase of the research, ideas and concepts from academic work on transformative R&I policy were introduced to JPI Climate through interactions with the author. A programme-level (SOLSTICE) theory of change was presented at a workshop with JPI and used as an interpretive framework to discuss the key ideas and goals underlying SOLSTICE. Presentation of these ideas resulted in engaged responses on the part of JPI representatives and detailed discussions about the relevance of these ideas in this specific context. For example, providing a context for Projects to share experiences and learning was discussed as a potential programme-level ‘value-adding’ activity. This idea was taken up at the midterm evaluation in a discussion session on how Projects might upscale their outcomes.

## 6. Discussion

The stated ambition of the SOLSTICE Call was to generate research that would contribute to socio-technical transformation addressed to climate change. SOLSTICE focused on three epistemic elements—SSH leadership, interdisciplinarity, and transdisciplinarity—for creating new knowledge and shaping the intended societal outcomes of the funded projects (Haddad et al. 2022; Ulmanen, Bergek, and Hellsmark 2022; Haddad and Bergek 2023). It should be recalled that while SOLSTICE was designed with socio-technical transformation as its major objective, it was not consciously influenced by transformative R&I policy thinking (Smits and Kuhlmann 2004; Boon and Edler 2018; Grillitsch et al. 2019; Ghosh et al. 2021; Molas-Gallart et al. 2021; Haddad et al. 2022; Schwaag Serger and Palmberg 2022). However, the results show that the SOLSTICE design team developed a Call reflecting some characteristics of a ‘third frame’ R&I policy (Schot and Steinmueller 2018). First and foremost, the *directionality* of SOLSTICE reflects an essential objective of transformative R&I policies to not only shape what research is producing by publicly funded science but to also target specific domains and levels of future societal impacts with these investments (Lindner et al. 2016; Schot and Steinmueller 2018; Diercks, Larsen, and Steward 2019; Grillitsch et al. 2019; Aagaard, Norn, and Stage 2022; Borrás and Schwaag Serger 2022; Haddad et al. 2022; Schwaag Serger and Palmberg 2022).

As described in the previous results section 5, the initial idea of a funding programme that would integrate SSH with natural science and engineering interdisciplinarily in climate change projects was subject to debate and negotiation. This debate was largely concerned with not being too prescriptive about participating disciplines, whilst also wanting to attract those research communities not ‘typically’ involved in climate change related research. This dilemma was resolved by the decision to mandate interdisciplinarity and SSH leadership of project consortia, with the latter being a factor that was felt to have been very attractive by leaders of successful proposals. JPI Climate could not be certain how this strategy would be received by the research community in the projects designed to fulfil the ambition of SOLSTICE, but were willing to *risk engaging in this policy experimentation* (Smits and Kuhlmann 2004; Grillitsch et al. 2019; Ghosh et al. 2021; Borrás and Schwaag Serger 2022; Haddad et al. 2022; Howoldt and Borrás 2023).

The design of the projects resulted in multi- and interdisciplinary combinations that were mainly SSH-focused, tended to include relatively similar fields (medium disciplinary disparity, Table 3), and in most cases were experienced in climate change research. The response of the research community was thus not quite as radical as might have been hoped by the Call designers:

We knew that we wanted to have SSH working on the topic. We didn’t want to specify which kinds of disciplines should engage with each other, e.g. history and mathematics, but in the original idea, it was more ambitious (Int\_1)

Here, there is room to extend the radicalness of *epistemic boundary spanning* (Borrás and Schwaag Serger 2022) in a potential future iteration of the Call.

Perhaps of greater relevance to epistemic diversity, interviews with LPs revealed a relatively high degree of modularity in the way consortia, projects, and research were designed, and consequently, how the production of knowledge was organized. The projects all differed in the way their multi-/interdisciplinary teams and the organizational structure of the work were configured. Collective production of outputs within the consortia and between their participating disciplines can only be demonstrated to a certain extent, particularly in the early phases. Most projects indicated that the final year of the projects would serve to bring together their distinctive (partner and discipline-based) contributions and collectively produce outputs dedicated to reaching project goals. At the same time, interviews also showed the perceived added value of the necessary efforts to build understanding and communication between the participating disciplinary partners—even if only for activities such as scientific publications that typically occur relatively late in the project cycle. This shows that the people involved were willing to engage in learning beyond their usual paths, even if it cannot be said in the context of this study whether *second-order learning* (Molas-Gallart et al. 2021) actually took place.

From the perspective of transformative R&I policy, the *experimentation* with SSH leadership and the mandating of interdisciplinary approaches can be considered a qualified success. More disparate interdisciplinarity under SSH leadership may lead to greater experimentation and innovation in research approaches and learning between distant disciplines. However, if increasing interdisciplinarity is a policy objective, then attention could perhaps focus more strongly on encouraging less modular (multi-disciplinary) project designs and on the timing and extent of the interdisciplinary collaborations included.

These findings are largely reinforced when considering the SOLSTICE preference for transdisciplinary research designs. In common with transformative R&I policy, a focus on *inclusive and participatory processes* and the *involvement of a wide range of stakeholders* were seen as essential for building the basis for societal transformation in the face of climate change (Ghosh et al. 2021; Borrás and Schwaag Serger 2022; Haddad et al. 2022; Howoldt and Borrás 2023). However, in the development of the SOLSTICE Call, the need to align with different national interests and eligibility criteria for beneficiaries restricted the involvement of societal stakeholders. This reflects the challenges of multi-level policy coordination identified in previous research (Weber and Rohrer 2012). From a theoretical and practical point of view, any *a priori* limitation on the possibility of including a wide range of societal stakeholders will affect the likelihood and type of transformative outcomes generated at the community level.

From the perspective of transformative R&I policy thinking, the successful project designs did not make a clear conceptual distinction between project outputs and outcomes. Project *outputs*, such as policy recommendations or toolboxes, were often described explicitly or framed implicitly as the main *outcomes*. Scientific publications (and ensuring scientific excellence) were cited as *outcomes* rather than as key *outputs*. Interviews revealed that Projects considered stakeholder participation important for later outcome-focused phases and understood that societal impact requires

the take-up of project results. However, Project leaders expressed uncertainty about delivering societal transformation. Institutional conditions, publication pressure, team capacities, and project timeframes were all limiting factors that contributed to rather traditional forms of dissemination being perceived as the main feasible driver for creating societal impact pathways, both through scientific channels and directly to societal stakeholders.

Dedicated activities that could institutionalize *second-order learning* (Molas-Gallart et al. 2021), feedback loops, or *reflexive assessments* (Weber and Rohrer 2012; Ghosh et al. 2021; Schwaag Serger and Palmberg 2022) of progress towards Project and Call-level goals were not built into SOLSTICE. Subsequent interactions between the author and JPI policymakers included reflections on how a future iteration of SOLSTICE may more fully embrace the characteristics of transformative R&I policy thinking. One area of policymakers' interest was related to better advising proposals to distinguish between their planned results, outputs, and outcomes. Guidance for proposals on how to describe the 'impact pathway' constructed through these elements and how societal stakeholders could be integrated throughout, beginning in the proposal framing stage, can also be seen as important learning for possible future Calls.

A second area of interest for policymakers was how to include *value-adding activities* at the SOLSTICE programme level to build synergies and learning opportunities horizontally between funded Projects. In the mid-term evaluation, a desire to promote exchange between the projects emerged—amongst both JPI representatives and projects—but the implementation strategy remained unclear. Deepening European cooperation in SSH approaches to mitigating and adapting to climate change would undoubtedly benefit from greater horizontal interaction and learning among the funded projects, including through simple mechanisms such as collective workshops. Such activities could even be extended to international networks among SSH researchers working on societal aspects of climate change.

Such approaches of introducing second-order learning and feedback loops among projects and policymakers suggest opportunities to close gaps between transformative R&I policy thinking and existing policy practice. Transformative R&I policies emphasize the complexity of the system, contextual knowledge, societal inputs and contributions, and policy experimentation and adaptability as crucial to providing a basis for participatory learning. The experience of this study would support these ideas. Policy experts, policymakers, researchers, and all interested stakeholders would profit from jointly engaging and working cooperatively with these ideas to experiment with, better understand, and develop the effectiveness of their efforts. This result reflects calls for more participative and democratic models and practices of governance for R&I emanating from work in the field of responsible research and innovation (Stilgoe, Owen and Macnaghten 2013).

There are limitations to this study that should be pointed out. Discussions between the researcher and JPI Climate considered the idea of a full formative evaluation to accompany the entire funding programme, as described in transformative R&I policy literature (Molas-Gallart et al. 2021; Rohrer, Coenen, and Kordas 2023). Significant challenges emerged regarding the time- and labour-intensiveness of such

an undertaking, particularly for extremely busy officials with high-level policy-making responsibilities, and the feasibility of the method for internationalized research initiatives such as SOLSTICE. From the perspective of having conducted a less expansive formative evaluation process alongside SOLSTICE, these questions do have merit and probably need to be carefully considered by both policy scholars and policy-makers interested in such an approach. Following from this, parts of the process could only be analysed retrospectively, as the formative evaluation commenced when the proposal evaluation was completed, and projects were funded. Interviews were conducted with LPIs of funded Projects, meaning that the experiences of other consortium members were not fully discoverable. Finally, understanding of the research community's response to SOLSTICE was limited by the inability to access unfunded proposals submitted to the Call, due to data protection restrictions.

## 7. Conclusions

This study has investigated how an R&I policy with transformative ambitions was designed and implemented. It has analysed how addressing gaps between theory and practice may improve policy outcomes. Policy makers are increasingly interested in how their interventions can shape socio-technical change. At the same time, policy scholars are developing theories and concepts for the design and implementation of transformative research and innovation policies. As this study has shown, a gap exists between the practices of these two communities. The arc of transformative R&I policy ideas is envisaged to extend from initial policy designs to demonstrable societal outcomes. In the case of SOLSTICE, transformative ambitions were incrementally eroded by the complex and pragmatic demands of trans-national policy-making. The most significant barrier identified is the national-level criteria that limit the ambition of fully involving non-scientific partners and stakeholders as eligible project participants.

The process perspective applied in this study has shown that there are apparent opportunities to use transformative R&I policy thinking to support and enrich innovative policy-making with transformative ambitions. As the study demonstrates, policy makers were receptive to engaging with these principles to promote socio-technical change in the context of climate change. There was a willingness to collaboratively learn and experiment to improve the chances that their transformative policy ambitions could deliver desired societal outcomes in the future.

It appears evident that introducing theoretical thinking and practical evidence about transformative innovation would be more relevant if these ideas and concepts were discussed and debated in mutual exchanges with all stakeholders from the start of the policy design process. Integrating programme-level activities to provide in-the-run opportunities for researchers and projects to develop and adapt their understandings of these policy ambitions, how they might be achieved, and supporting them to learn and experiment also appear important here. In conclusion, building bridges between theoretical policy concepts and pragmatic policy design and implementation requires sustained engagement among all relevant actors.

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## Notes

1. [https://jpi-urbaneurope.eu/wp-content/uploads/2016/12/Joint-Programming-Initiatives\\_joint-brochure.pdf](https://jpi-urbaneurope.eu/wp-content/uploads/2016/12/Joint-Programming-Initiatives_joint-brochure.pdf)
2. <https://jpi-climate.eu/about-us/>
3. <https://jpi-climate.eu/programme/call-2013/>
4. The main authors from the JPI, Jennifer West and Elisabeth Worliczek, were supported by contributors from Italy, the Netherlands, Sweden, Ireland, France, and the UK, with inputs and advice from JPI Climate Governing Board and Transdisciplinary Advisory Board.
5. The draft proposals were used only as a tool for finding the appropriate evaluators and not as a basis for the final evaluation.
6. Five projects received cost-neutral extensions until mid-2024.
7. The 'virtual common pot system' (*Call Secretariat 2019a*) was based on the following maximum totals: Austria: 400,000€, Czech Republic: 500,000€, Finland: 700,000€, France: 1,000,000€, Italy: 500,000€, Ireland: 500,000€, Latvia: 300,000€, Norway: 1,000,000€, UK: 1,500,000€

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