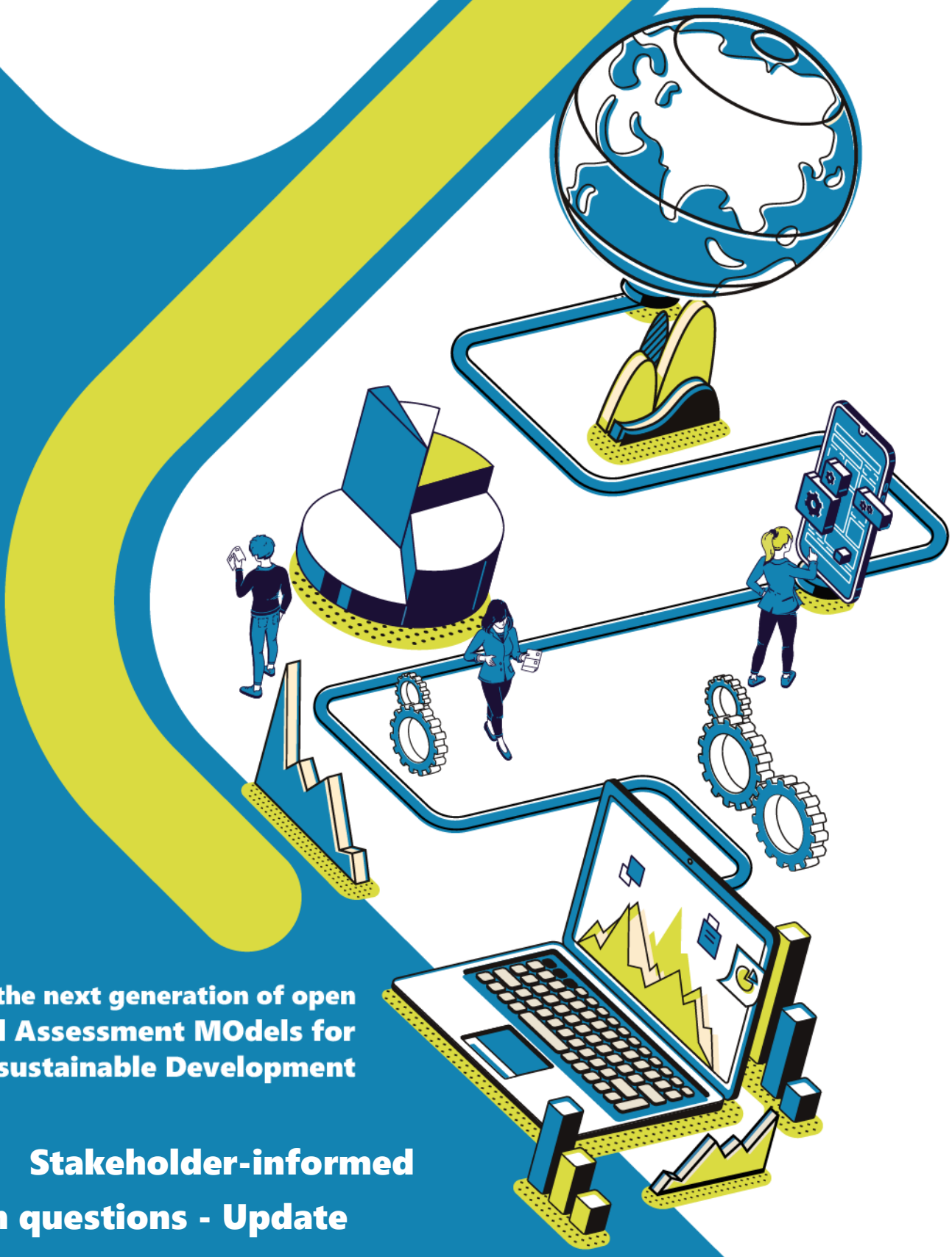
DIAMOND



Delivering the next generation of open Integrated Assessment MOdels for Net-zero, sustainable Development

D2.5 – Stakeholder-informed research questions - Update

WP2 – Codesign

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29/05/2025

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EC Summary Requirements

1. Changes with respect to the DoA

No changes with respect to the DoA.

2. Dissemination and uptake

This deliverable will be used by WP5 – Apply and Explore, which focuses on developing new scenarios for integrated assessment modelling. The research questions presented in this deliverable will guide scenario development and assessment in WP5. At the same time, WP3 - Update and Upgrade, and WP4 - Integrate and Expand can also make use of these questions, should the models and modules in these work packages require modifications in order to run scenarios developed from the research questions developed in this deliverable.

Not all research questions presented in this report can be addressed in DIAMOND. Therefore, this deliverable also presents research questions that other projects can make use of. The transdisciplinary process presented in this deliverable can also be used by other projects, and the reflections offered on how research questions are taken up by modelling teams, offers a critical viewpoint in the IAM and scenario development discourse that can be of value to other projects.

3. Short summary of results

The DIAMOND project undertakes a transdisciplinary (TD) approach to update, expand, open, and develop scenarios of six Integrated Assessment Models (IAMs), aiming to support the transition to net zero emissions and sustainable development. WP2 - Codesign leads this TD approach, which is broken down into three phases. *Phase 1: Toward Mutual Understanding* is based on the concept of "joint-problem framing" indicated by the TD scientific literature as the initial step within a fruitful stakeholder engagement plan. The aim and output of this phase is a set of stakeholder-informed research questions that are in turn co-created in three stages. As a familiarisation stage, Stage 1 aimed at finding common ground among DIAMOND partners and their work. Stage 2 focused on reaching mutual understanding of the goals and aims of the TD approach to be implemented by DIAMOND partners. Stages 1 and 2 were presented in Deliverable 2.4. Stage 3 is presented in this deliverable, which engages stakeholders to co-design a set of research questions that guide the development and assessment of scenarios in DIAMOND. This deliverable serves to finalise Phase 1: Toward mutual understanding. We present the process followed in the third stage, the co-produced knowledge that shaped the research questions, the set of research questions that will guide scenario development and assessment and reflections on the implications of the findings. The report serves as a guide on which questions can be taken up in the DIAMOND project but also highlights some areas for future research by transparently presenting all the research questions and the limitations and opportunities emerging from the TD process, including those that IAMs may have a limited capacity to represent.

4. Evidence of accomplishment

This report—and its annexes, including internal reports and results.

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Preface

DIAMOND will update, upgrade, and fully open six Integrated Assessment Models (IAMs) that are emblematic in scientific and policy processes, improving their sectoral and technological detail, spatiotemporal resolution, and geographic granularity. It will further enhance modelling capacity to assess the feasibility and desirability of Paris-compliant mitigation pathways, their interplay with adaptation, circular economy, and other SDGs, their distributional and equity effects, and their resilience to extremes, as well as robust risk management and investment strategies. This will be done via integration of tools and insights from psychology, finance research, behavioural and labour economics, operational research, and physical science. The project will develop a transdisciplinary scientific approach to legitimise the implementation process and cocreate research questions that stretch the frontiers of climate science, as well as establish vibrant communities of practice to transparently open model enhancements and to develop capacities, thereby lowering the entrance barriers to the established IAM community.

ICCS	INSTITUTE OF COMMUNICATIONS AND COMPUTER SYSTEMS	EL
BC3	ASOCIACION BC3 BASQUE CENTRE FOR CLIMATE CHANGE - KLIMA ALDAKETA IKERGAI	ES
CESAR	KRATENA KURT	AT
CICERO	CICERO SENTER FOR KLIMAFORSKNING	NO
CYI	THE CYPRUS INSTITUTE	CY
E4SMA	ENERGY ENGINEERING ECONOMIC ENVIRONMENT SYSTEMS MODELING AND ANALYSIS SRL	IT
HOLISTIC	HOLISTIC IKE	EL
COMILLAS	UNIVERSIDAD PONTIFICIA COMILLAS	ES
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Oxford	THE CHANCELLOR, MASTERS AND SCHOLARS OF THE UNIVERSITY OF OXFORD	UK
UCL	UNIVERSITY COLLEGE LONDON	UK

Executive Summary

Integrated assessment models (IAMs) are increasingly used to inform policy decisions towards net zero emissions and sustainable development. However, IAMs are often met with scepticism, with non-modellers commonly considering them as black boxes that lack stakeholder engagement and transparency. To further build on a more inclusive modelling approach and move from a more consultative approach to codesign and coproduce IAMs with stakeholders, we have designed a transdisciplinary modelling approach. Transdisciplinary (TD) research focuses on addressing real-world problems that require scholars from different disciplines and stakeholders to come together. Transdisciplinarity is also underpinned by openness and reflexivity in the process of coproducing and integrating knowledge toward effective solutions for real-world problems such as the goal of IAMs to inform policy decisions toward net zero emissions and sustainable development.

As part of the DIAMOND project, WP2 "Codesign" leads the TD research approach to coproduce, co-own and open six IAMs. Our approach has been tailored to the requirements of DIAMOND. It follows three phases. Phase 1 (*Phase 1: Toward mutual understanding*) familiarises project partners with the problem space and then jointly frames the project boundaries from February 2023 – May 2025. The second phase (*Phase 2: Toward model coproduction*) involves coproducing solution-oriented knowledge that addresses the problem frame from June 2025 – November 2025. Finally, the third phase (*Phase 3: Toward model co-ownership*) integrates and applies the coproduced knowledge into societal and scientific practices, from December 2025 – November 2026.

Phase 1, led by ETH Zurich, is divided into three stages and this deliverable presents the results from Stage 3. Phase 1's output is a set of stakeholder-informed research questions, presented in this deliverable, guiding Phase 2's coproduction activities. Stages 1 and 2 were conducted between March and November 2023 and are presented in *D2.4 Stakeholder-informed research questions* (Briers & Vienni-Baptista 2023). Stage 3 focused on producing research questions for scenario development and assessment for eight relevant themes grouped into three focal groups – Climate Change (with themes Climate Change Impact, Land Use and Forestry); Climate Action (Disruptive Events, SDGs, and Circular Economy); and User Driven Scenarios (Labour in Transition, Finance in Transition, and People in Transition). These groups and themes were selected in collaboration with *WP5: Apply and Explore,* based on the key scenario themes that will be developed and explored in the different WP5 tasks.

Stage 3 was designed as an engaged approach to sustain the transdisciplinary process in DIAMOND. Methods included an in-person workshop with DIAMOND partners, a stakeholder webinar, and 7 multistakeholder discussion group workshops (online), a survey with DIAMOND modellers, and several online meetings with DIAMOND partners. Multistakeholder discussion groups are flexible, tailor-made formats catering to different needs of the codesign activity. After each workshop, the data was synthesised in a series of internal reports to begin the process of co-producing the updated research questions.

The three outputs of Stage 3 are 1) a synthesis of the co-produced knowledge for the eight themes resulting from each co-productive activity; 2) 41 research questions (around five research questions per theme), and 3) a reflection on the coproduced knowledge. Results from Stage 3 include ways to move beyond research questions and to the contexts within which questions are answered; the depth and degree to which research questions are answered by IAMs; how to translate findings across themes and contexts; and challenges and opportunities of the transdisciplinary approach. These outputs aim for transparency of model limitations and assumptions, to create an open modelling process where external actors understand the implications of the different research questions that were produced. In Phase 2: *Towards knowledge co-production,* Phase 1 outputs will be integrated into WP3, WP4, and WP5 that span scenario development, and assessment, and guide model development to enable the integration of newly developed scenarios into model runs.

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1 Introduction

Integrated assessment models (IAMs) are increasingly used to inform policy decisions towards net zero emissions and sustainable development. However, IAMs are often met with scepticism, with non-modellers commonly considering them as black boxes that lack stakeholder engagement and transparency (van Beek et al, 2020). To address these criticisms and enhance the transparency and accuracy of models, an increasing number of modelling teams that focus on climate action are adopting interdisciplinary, transdisciplinary, and participatory approaches (Jäger et al. 2023; Lehtiniemi and Paloniemi 2023).

From Month 1 in the DIAMOND project, the team has embarked on a transdisciplinary design integrated into the conception of the research and modelling processes. Transdisciplinary approaches become essential when diverse academic and non-academic actors collaborate to find effective solutions for real-world problems, such as combating climate change through net zero emissions goals (Lang et al. 2012; Hoffmann et al. 2017). While participatory modelling engages non-academic actors or stakeholders for feedback and validation of model assumptions, a transdisciplinary (TD) approach moves towards co-production of knowledge in science and policy (Galende-Sánchez and Sorman 2021; Nikas et al. 2020). Recognising that knowledge flows across communities, the TD approach ensures a policy-relevant yet impartial flow of comprehensive and comprehensible information for selected stakeholders.

Thus, the DIAMOND project–*delivering the next generation of open integrated assessment models towards net zero, sustainable development*–aims to update, upgrade, and expand six IAMs, using a TD approach, to better inform decision-making around adaptation to and mitigation of climate change.

A dedicated Work Package, *WP2: Codesign* (WP2), ensures this TD approach. It establishes, operationalises, and manages a cocreation mechanism driving all model and scenario exercises in the project. This mechanism places actors from relevant stakeholder groups (scientists, policymakers, industries, citizens) at the project's core, fostering mutual understanding for coproducing and co-owning models and knowledge. WP2's TD approach follows three phases according to Lang et al. (2012)'s ideal TD conceptual model (elaborated in Section 2). Accordingly, *Phase 1: Toward mutual understanding* is followed by a *Phase 2: Toward knowledge coproduction* starting in May 2024, and finally, *Phase 3: Toward model co-ownership in 2025/26*, that integrates findings from Phase 1 and 2 and finalises the codesign process in the DIAMOND project.

Phase 1 involves reaching mutual understanding through a joint problem-framing approach (Pearce and Ejderyan 2020). Joint-problem framing is the process of collectively defining the problem space within DIAMOND, establishing a level of understanding and convergence of multiple perspectives to lay the foundation for the coproduction and co-ownership phases in Phase 2 and Phase 3. WP2: Codesign breaks down the joint problem framing (Phase 1) into three stages, elaborated in Section 2 of this deliverable. This deliverable focuses on Stage 3, involving stakeholders in cocreating DIAMOND's stakeholder-informed research questions that will guide model development and the scenario definition space, and builds on D2.4 which presented the groundwork and findings from the first two stages.

This deliverable is structured as follows. Section 2 highlights the importance of TD modelling and elaborates on the joint problem framing approach and the methods used in Phase 1. Sections 3 gives an overview of Stages 1 and 2, and Section 4 presents the results from Stage 3. Finally, we synthesise and prioritise our results, outlining the next steps of integrating the Stage 3 outputs into the DIAMOND tasks, commencing in June 2025.

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2 Transdisciplinary research approach

In DIAMOND, we take on the understanding that transdisciplinary (TD) research is a process involving scientific and societal actors that collaborate to address complex societal problems towards better addressing solutions for sustainability challenges (Pohl et al. 2021; Lemos et al. 2018; Mauser et al. 2013; Polk 2014). It combines an interdisciplinary foundation with an openness to "new encounters, coproduction of knowledge and reflexivity" (Vienni-Baptista et al. 2023). A central feature of transdisciplinarity is collaborating with stakeholders with the aim of arriving at solutions sustained and supported in different worldviews, often referred to as *stakeholder engagement*. Thus, we define the term 'stakeholder' as any societal actor, expert or non-expert, that affects or is affected by the research mission and outcomes (Reed et al. 2009), who are not part of DIAMOND's consortium. When referring to 'engagement', it can take on various forms depending on the task, for example, defining research questions, and/or validating model results. Some stakeholder engagement may happen in targeted meetings, while other forms may take the shape of large, open-format discussions. The different variations of stakeholder engagement include informing, consulting, involving, collaborating with, and empowering stakeholders (Durham et al, 2014).

In the last years, participatory modelling has been developed as an alternative for more engaged practices in the modelling process, with stakeholders (van Vuuren et al. 2012; Salter et al. 2010). However, such applications remain scarce (Koasidis et al., 2023), while the degree of involvement in participatory modelling has been limited, with stakeholders often being engaged to validate results and research questions and thus lack ownership over models (Braunreiter et al. 2021). Legitimacy and robustness of modelling outcomes is needed to build trust and ownership over the modelling results and recommendations, and ensure that modelling results can meaningfully inform important climate action policy (McGookin et al. 2021).

Through a TD modelling approach that is open and reflexive, DIAMOND pushes for models to be codesigned, coproduced and co-owned by the stakeholders as well as by DIAMOND partners. In the case of DIAMOND, the consortium has an added feature that imprints challenges but also opportunities to improve methods and tools for transdisciplinary modelling, i.e., the diversity and number of partners involved in the project. While this is a typical characteristic of Horizon Europe projects, we also acknowledge that investing time in a joint problem framing phase will guarantee a truthful and genuine co-designed output. A well-designed and facilitated TD approach gives actors the time and space to build trust and ownership through a deep understanding of different perspectives and guarantee a more grounded societal impact to address net zero emissions and sustainable development (Jäger et al. 2023).

The TD approach we have tailored for DIAMOND follows three phases as illustrated in Figure 1. The initial phase is to familiarise with the different individual mental models[1] that define the problem space, and from that point jointly frame the project boundaries. In DIAMOND, we broke down the first phase into three stages, first focusing inward to familiarise with consortium partners before engaging external actors. The second stage in phase one also involved understanding who the stakeholders are in the project, while formulating an initial stakeholder group that will continue to adapt and grow. By focusing on building a common ground among partners, we ensured that we approached a carefully considered group of stakeholders with coherently defined research boundaries to create a solid foundation for collaboration with stakeholders in the final stage of Phase 1. This deliverable focuses on Stage 3 of the first phase, sharing the process we followed to co-produce a set of research questions that

[1] internal representation that people use to understand, predict, and reason about the world

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guides phase two, and presenting and briefly discussing the co-produced research questions.

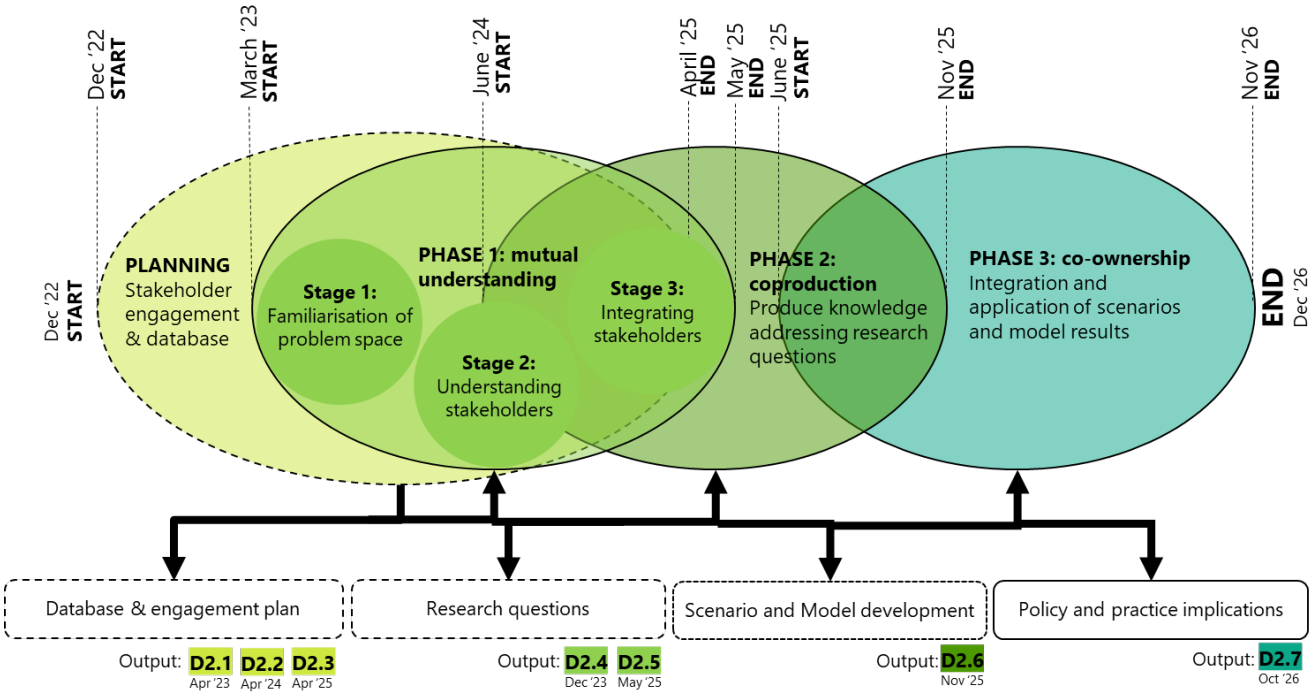

Figure 1. The three phases of the TD approach and the three stages of Phase 1 Mutual Understanding. Each stage, and each phase's output (Deliverables), serves as knowledge to feed into the next phase.

Phase 2 involves jointly producing solution-oriented knowledge that addresses the research questions defined in Phase 1 with stakeholders. Finally, Phase 3 involves integrating and applying the coproduced knowledge into societal and scientific practices (ibid) to address the problem space that was jointly defined in phase 1. The TD process is also often conducted in iterative cycles, and this phased process is not always linear (Wickson et al. 2006). For example, Phase 2 may reveal new and unexplored territories of the problem space, which requires one to return to Phase 1. As this deliverable focuses on the final stage of Phase 1 of the TD approach, we briefly summarise the first two stages, which are presented in *Deliverable 2.4 Stakeholder-informed Research Questions*, and focus on presenting the process followed to co-produce research questions for scenario development and assessment.

2.1 Phase 1: Toward mutual understanding

In Task 2.2, *Phase 1: Toward Mutual Understanding*, we developed an understanding of the problem space to navigate the complexity and uncertainty that IAMs may entail (Briers and Vienni-Baptista, 2024) and establish goals and strategies of codesigning the scenario definition space, explored through a set of co-created research questions.

Contrary to the title "mutual understanding", the aim of this phase it not to reach consensus around the set of problems to address, or which methods to follow in the codesign process. Rather, this phase focuses on bringing to the fore different perspectives and keep them alive under a common point of reference in relation to the research questions that scenarios should consider in their development and assessment (Bornemann and Christen 2020). As Bornemann and Christen (2020) point out, this process of understanding the multiple perspectives enables the development of an "overall problem framework", capturing and linking different context-specific understandings of the research focus. Such an approach allows for a more complex understanding of the problem space and thus may guide the solution space more sensitively. Below we elaborate on the approach that we have

used to develop a mutual understanding of this "overall problem framework" in DIAMOND and co-create a set of research questions as an output to this phase.

Phase 1: Toward mutual understanding involves three stages (Figure 1) and follow an approach referred to as "joint problem framing" (Lang et al. 2012; Pearce and Ejderyan 2019). Joint problem framing is a process where a group of people collaborating on a certain 'real-world problem' expose, share and explore relevant perspectives of a problem situation, thereby restructuring individual perceptions to determine jointly framed goals and criteria to create effective solution to the 'real-world problem' (Pachoud et al. 2023).

Stages 1 and 2, were targeted towards reaching mutual understanding of the codesign process among DIAMOND partners and was the focus of D2.4 Stakeholder-informed Research Questions. The importance of taking the time to adequately define the project mission, goals, opportunities, and barriers before stakeholder engagement takes place, has a proven positive impact on the outcomes the co-design process has (Durham et al. 2014, Mielke et al 2016).

Stage 1 familiarised partners with, and jointly defined, DIAMOND's problem space (Pearce and Ejderyan 2020). Stage 2 focused on understanding stakeholder engagement through the partners' perspectives using emerging themes from Stage 1 (Mielke et al. 2016; Reed et al. 2009; Durham et al. 2014). Stage 3, presented in this deliverable, aims to achieve mutual understanding of the co-production process between DIAMOND stakeholders and DIAMOND partners. The final output for Phase 1, and the result of reaching mutual understanding, is a set of cocreated research questions that will guide the coproduction of model improvements and the scenario definition space in *Phase 2: Toward model coproduction*.

In Phase 2, we will integrate the set of 41 research questions produced in Phase 1 into the different DIAMOND tasks, selecting which questions will get taken forward in the project. We understand and transparently communicate how the questions will get taken forward, documenting why certain questions cannot get taken forward and highlighting those questions as important for future research. This exercise will be done in an in-person workshop in June 2025 at the annual DIAMOND General Assembly, in a joint process with WP5 partners.

To implement a transdisciplinary research process for codesigning new model capabilities and scenarios with stakeholders, our team conducted a multi-layered qualitative strategy combining different methods and tools (Seawright 2016). An initial abductive approach (Tavory, 2014) was used, where methods in the beginning of each stage offered a broad and open format to ensure an inclusive environment for all participants, followed by more focused and deductive methods used to clarify and refine results from the earlier stages of engagement (Azungah 2018). We apply a qualitative research design entailing multi-stakeholder discussion groups (Fry, 2021), and dialogue-methods (McDonald et al. 2009) in online and in-person workshop and focus group formats (Kitzinger 1995). Collaborative writing was used to collect WP3 and WP5 DIAMOND partners' goals and research focus, defining and refining the project boundaries. A webinar served to familiarise external collaborators, get initial feedback of project boundaries, and scope interest for further collaboration. Following these methods, we employed surveys and voting or validation sessions to refine and further validate data that was then integrated in the final set of research questions. Data analysis was done using situational analysis (see below) as inspiration.

An integrative approach was used to synthesise workshop data that informed the research questions, forming an adjusted set of research questions after each workshop. Situational and Thematic analysis was used to analyse, synthesise and integrate data (Clarke et al. 2003). Thematic analysis is a qualitative to identify, analyse, and report patterns (themes) within the data (Braun and Clarke, 2019). The approaches have underpinnings in Grounded Theory (Strauss and Corbin 1994) and seek to explore the multiplicity of perspectives and the processual nature of modelling improvements in DIAMOND, attending carefully to differences, complexities, and range of variation in the data, including discourse data and analyses (Clarke et al. 2015).

The first maps—i.e., situational maps—take on a post-modern approach of elucidating complexities (Clarke et al. 2003). From here, the often invisible is made visible, and through analysing maps, key themes can be identified and taken forward for further investigation (Clarke et al. 2018). Situational analysis is embedded within grounded theory (Strauss and Corbin 1994) and follows three steps. Firstly, one draws out an abstract map of all the data collected, secondly, one begins to order the map into a working version, and thirdly, one does a relational analysis with the situational map. When doing a relational analysis, themes, connections, and gaps begin to emerge. The different elements are coded, categorised, and grouped (ibid). This type of map is initially made during the early design phase, gaining a tentative sense of important relations among dimensions of analysis (Clarke et al. 2015). Second, what Clarke et al call "Social worlds" and "Arenas maps", lay out all the collective actors and the arena(s) of commitment within which they are engaged in ongoing discourses and negotiations. Such maps offer interpretations of the broader situation, taking up its social organisational, institutional, and discursive dimensions (ibid). Last, positional maps lay out the major positions taken, and controversy found in the problem space. They allow multiple positions and even contradictions to be articulated. As already proved in other cases (ibid; Fosket 2016; Gagnon et al. 2016) this method is also relevant for policy research, which is the focus of DIAMOND as well.

The methodological underpinnings for the workshops followed in Stage 3 of *Phase 1: Towards mutual understanding* is the dialogue method (Hubbs et al., 2021) and multi-stakeholder discussion group (Fry, 2021), a flexible format that allows us to adjust the engagement format according to the stakeholder needs, workshop focus and stage of the codesign process. Doing so allows exploring the multiplicity of perspectives on the themes and how models and scenarios address concerns from the target groups, attending carefully to differences, complexities, and range of variation in the data (Charmaz and Thornberg 2021).

3 Overview of Stage 1 and Stage 2

Stages 1 and 2 were conducted between March and November 2023. These stages offered a reflexive and open process focused on familiarising with DIAMOND's 'problem space' to reach mutual understanding of the codesign process within the Consortium. The purpose of these stages was to provide a solid foundation for the stakeholder-engagement process initiated in Stage 3 and the sub-sequent co-productive process in Phase 2 (see Figure 1).

3.1 Stage 1: Familiarisation of the problem space

Stage 1 (March – June 2023) focused on familiarising with DIAMOND's 'problem space', outlining project members' perceptions of the DIAMOND mission and opportunities; gaps and limitations of IAMs; and stakeholder engagement barriers and opportunities. The process of familiarisation helped DIAMOND partners enter a reflexive practice and identify their own mental models related to the DIAMOND project. The outcome of this stage was to create a clear picture of DIAMOND's problem space before entering the next stage that involved understanding the codesign activities and process in more detail.

Stage 1 was designed as in-person visits to teams who are working to expand, update and open six emblematic IAMs. The workshops lasted two to three hours and had two to three participants representing their partner organisation working on one of the six IAMs in DIAMOND. In total 21 participants contributed to the Stage 1 workshops.

Using the focus group methodology (Kitzinger 1995), information was collected on the participants' perceptions of:

1. DIAMOND's mission and opportunities
2. Gaps and limitations of IAMs
3. IAM's and stakeholder engagement
4. Modelling team's work related to DIAMOND's mission

Twelve questions under the above four themes guided the workshop. Participants were given *alone-together* time to answer each question on cards (Figure 3). This was followed by a discussion where participants presented and elaborated on their answers to the question. Extensive notes were taken during this discussion that were used in the analysis.

Stage 1's output was a set of takeaway questions addressed to DIAMOND partners around 1) the DIAMOND mission and opportunities; 2) the gaps and limitations of IAMs; and 3) stakeholder engagement barriers and opportunities. The takeaway questions guided the next steps taken in Stage 2 with the aim of reaching mutual understanding of codesign within the DIAMOND consortium. Some of the questions were not dealt with directly in the Stage 2 workshops because they fell outside of WP2's focus as defined in our deliverables and milestones. Decisions on what to include in the Stage 2 workshops were based on how to concretely plan codesign activities that will commence in Phase 2 of WP2: Codesign.

3.2 Stage 2: Understanding stakeholders

Stage 2 (June – November 2023) focused on reaching mutual understanding within the consortium, exploring how partners envision Phase 2 co-production activities and clarifying DIAMOND partners' understandings and expectations of the stakeholder engagement process.

Stage 2 focused on understanding codesign activities and outputs through the partners' perspectives using emerging themes from Stage 1. Two online workshops were organised in June 2023 within the DIAMOND

consortium to look at the intersection of the different themes presented in the Stage 1 findings and integrated them, focusing on:

1. Prioritising Stage 1 takeaway questions
2. Understanding the differences between stakeholders
3. Matching stakeholders with the inputs/roles required.
4. Addressing stakeholder challenges, different methods to improve stakeholder engagement and communication of different components of IAMs.

The output was a set of activities that aim to improve coproduction and the accompanying stakeholder engagement. These activities fall under three themes. Firstly, strengthening the external and internal community of practice allows DIAMOND to share experiences and transfer tacit knowledge on coproducing model development and scenario design. Secondly, focusing on developing a richer understanding of stakeholders, when to engage them, how to improve communication with them and how to achieve a heterogenous representation of stakeholders can achieve more effective stakeholder engagement. Finally, defining targets focus areas for coproduction activities in model and scenario development can aid in managing expectations and increasing uptake of models to inform policy.

The first two stages are a necessary and important step to codesign a set of research questions with stakeholders in Stage 3, as discussed in this deliverable. Taking the time for this preparatory phase to reach mutual understanding within DIAMOND before engaging stakeholders builds a more solid foundation for the transdisciplinary process (Durham et al. 2014). Doing so before integrating stakeholder perspectives proves to be valuable by adequately preparing partners in approaching stakeholders in a well-organised, clearly defined manner (Mielke et al. 2016). It also allows partners to familiarise with diverse kinds of stakeholders, create a richer understanding of codesign processes, and shift their perceptions of how, when and where to involve which stakeholders in the project (Krütli et al. 2010; Durham, et al, 2014; Mielke, et al, 2016; Reed, et al, 2009). By doing this internal preparation phase, we provide a rich picture that allows stakeholders to contribute to and provide their own perceptions of the codesign process in DIAMOND more effectively. With this, the results from these two stages may change based on stakeholders' own perceptions, thereby also contributing to planning the codesign process and activities (Krütli et al. 2010). This will account for more informed, well-embedded and impactful outputs at the end of the DIAMOND funding period.

4 Stage 3: Stakeholder-informed research questions

Stage 3 of the co-design transdisciplinary modelling approach focused on co-designing the boundaries that inform scenario development and assessment by producing a set of guiding research questions with stakeholders and DIAMOND partners. This stage was developed in close collaboration with *WP5: Apply and Explore* and is linked to the model developments in WP3 and WP4 (see Figure 2). WP5 focuses on stretching the frontiers of the updated and enhanced models produced in WP3 and WP4, through the exploration of gaps in scenario development and the conception of a novel scenario space.

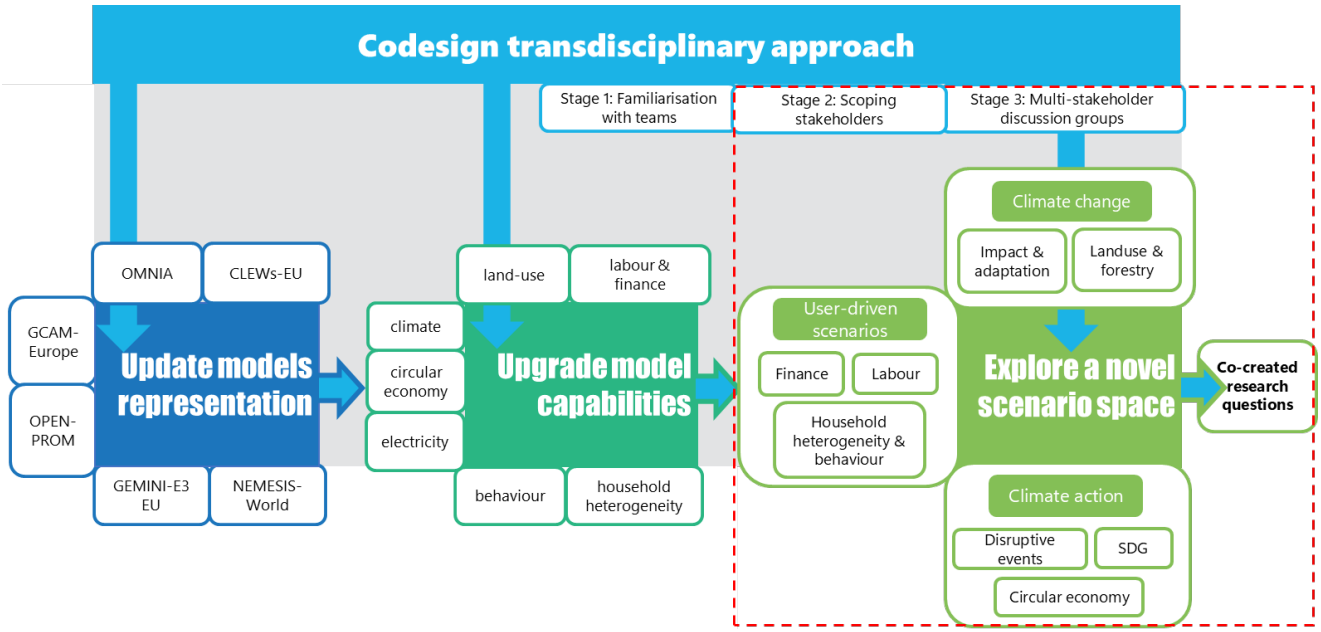

Figure 2. Interconnections between DIAMOND's WP2 (Co design), WP3 (Update models); WP4 (Upgrade models); and WP5 (Explore a novel scenario space).

Stage 3 took the format of a series of multi-stakeholder workshops that aligned the needs of DIAMOND partners to those elaborated by a diverse group of selected stakeholders. The aim was to jointly define the boundaries of the novel scenario space, highlighted by a set of co-produced research questions falling under eight themes that were subdivided into three groups: (i) Climate Change Scenarios, (ii) Climate Action Scenarios, and (iii) User-driven Scenarios. The detailed themes in scenario development were outlined according to the DIAMOND project description and can be seen in the above figure 2 – being Climate Impact, Land use and Forestry, Disruptive Events, SDGs, Circular Economy, Finance, Labour, Household Heterogeneity and Behaviour (People). These themes were then grouped according to overarching similarities. *Group 1: Climate Change Scenarios*, focuses mainly on how the impact of climate change and how we could adapt to climate, looking especially at land use change and the impact on forestry. *Group 2: Climate Action Scenarios*, focuses more how we react to climate change, with policies such as SDGs, taking action on sudden shocks in disruptive events, or implementing sustainable measure such as Circular Economy measures. *Group 3: User-driven Scenarios* looks at how society is represented in scenarios by looking at representation of labour, finance, and human behaviour, and household heterogeneity.

The Stage 3 workshops took place in three iterations online and in-person between May 2024 and April 2025 with selected DIAMOND partners and stakeholders, according to each theme focus.

4.1 Methods

The methods applied in Stage 3 are founded on the process initiated in Stages 1 and 2 of the transdisciplinary

modelling approach (see the overview section). This means that they are embedded in a co-productive process (following Nowotny et al., 2001), that allows for participatory components to be decided and built simultaneously with DIAMOND partners (in this case those from WP5 and listed as contributors to this report) and selected stakeholders. Therefore, the methodological approach described in this section, follows the principles of a transdisciplinary research design (Briers & Vienni-Baptista, under review), with moments of iteration between phases and re-framing if necessary. In what follows, we elaborate on the main methodological features of Stage 3.

4.1.1 Participant selection and representation

DIAMOND partners were a core part of the process, but we progressively narrowed down their involvement and increased stakeholder involvement in the co-creation process after each iteration. Notably, the first iteration involved all DIAMOND partners. From the second iteration onwards, we invited participants who had expertise in the themes and topics to collaborate on organising the workshops, inviting the stakeholders, and revising the research questions after each workshop. The themes and topics of focus align with the tasks set out by DIAMOND's work packages 4 and 5. We therefore contacted teams in each task and asked them to nominate or volunteer a name to represent the specific theme and topic. In total this amounted to 19 DIAMOND partners participating in the co-design activities. These group members also selected a group lead who was the main point of contact for WP2. Group members participated in a series of planning meetings and adjusted the research questions after each workshop using the synthesised report that WP2 produced. The group leads where the direct contact point for WP2 and were asked to participate in each of the workshops with stakeholders.

External participants in the co-design process were carefully and democratically selected to ensure that we had committed participation, with a diverse group of people, from industry, civil, society, policy and research. We also tried to consider gender and seniority diversity, and diversity in geographic location of the participants, focusing on the European context, given that DIAMOND focuses on Europe. The 12 group members across the three themes were asked to provide two names for each stakeholder category – industry representative, civil society representative, policy expert and thematic expert. We expanded our invitation list by requesting that stakeholders share our invitation to any colleagues they may think would like to join the opening webinar. To further diversify the categories of stakeholders invited, we used an existing data base of names collected during a survey on inclusive stakeholder engagement (Herbig, 2023). In total, 178 external actors were invited to attend the kick-off webinar, of which 52 attended. Of those attendees, 36 external actors attended one or two of the seven workshops hosted between February and April 2025 along side DIAMOND partners. Below are two tables indicating the diversity we achieve in the webinar and workshops.

Table 1 The diversity of participation in the kick-off webinar with external participants.

Participation diversity in webinar	Approximate number[2]
Total external participants (stakeholders)	**52**
Countries represented	16
Organisations represented	36
Policy perspective	11
Industry perspective	11
Civil society perspective	13

[2] according to Mentimeter survey, and/or stakeholder analysis following the webinar and workshops

Thematic expertise	11

Table 2 The diversity of participation in the multi-stakeholder discussion workshops with external participants.

Accumulative participation diversity in workshops	Approximate number[2]
Total external participants	**26**
Countries represented	11
Organisations represented	25 (of which 8 were universities)
Policy perspective	7
Industry perspective	6
Civil society perspective	8
Thematic expertise	5

4.1.2 Data collection

4.1.2.1 First iteration: scoping themes for the research questions

The first iteration of workshops only involved DIAMOND partners and served as a scoping exercise for WP3, WP4 and WP5 to find synergies in the research themes across the work packages. This was done by collaboratively writing in Microsoft Word (WP5) and Microsoft Excel (WP3). WP2 asked DIAMOND partners to brainstorm on research questions that highlighted their research focus and interest in DIAMOND, as well as the feasibility to address these interests in the models with a ranking from 1 (not feasible) – 5 (already possible). After collecting this data, WP2 integrated the different input into a map of Thematic Research Questions (Figure 4). This map highlighted high-level research questions, technical research questions and scenario research questions; which models and tasks were aligned with the different research questions; and the feasibility for models to address the research questions. The map also showed linkages across the different themes.

To finalise the first iteration, WP2 hosted an in-person workshop where all DIAMOND partners were invited to review the thematic research questions, adding their interests, priorities, adjusting and deepening the research focus in each theme. This final input was once again integrated into each theme, with additional detail added as shown in the schematic map and indicatively the Circular Economy map in Figure 3.

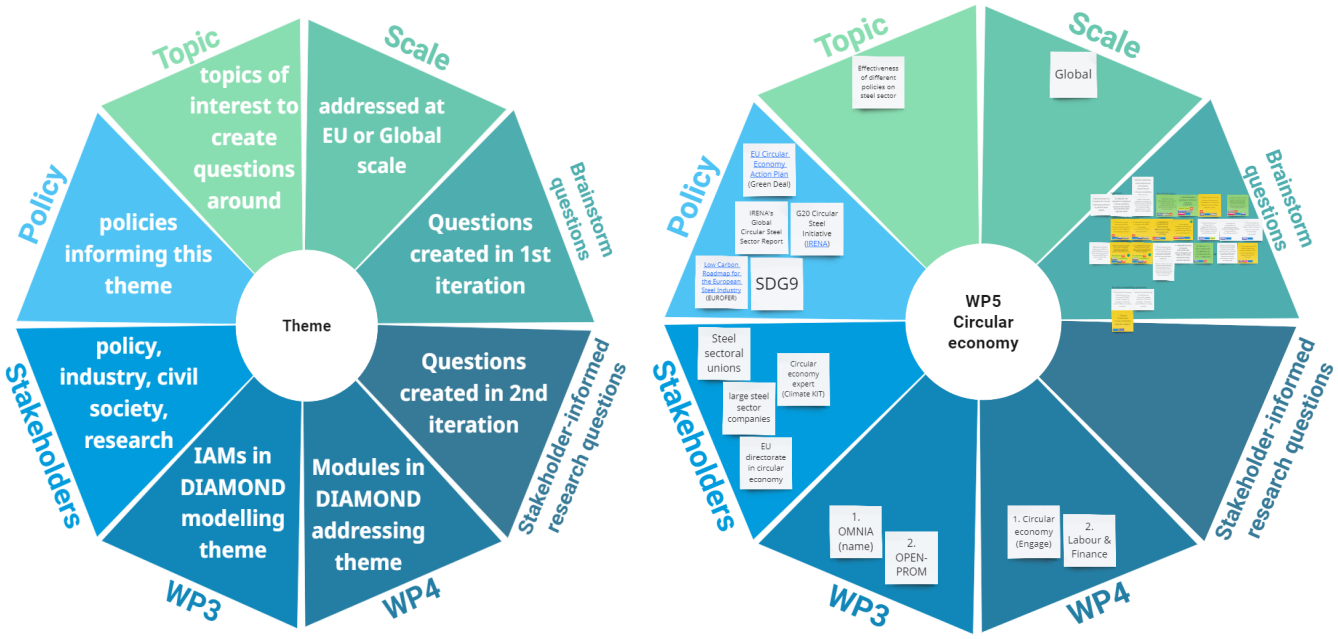

Figure 3. Mapping different elements that will inform research questions to guide scenario development and assessment

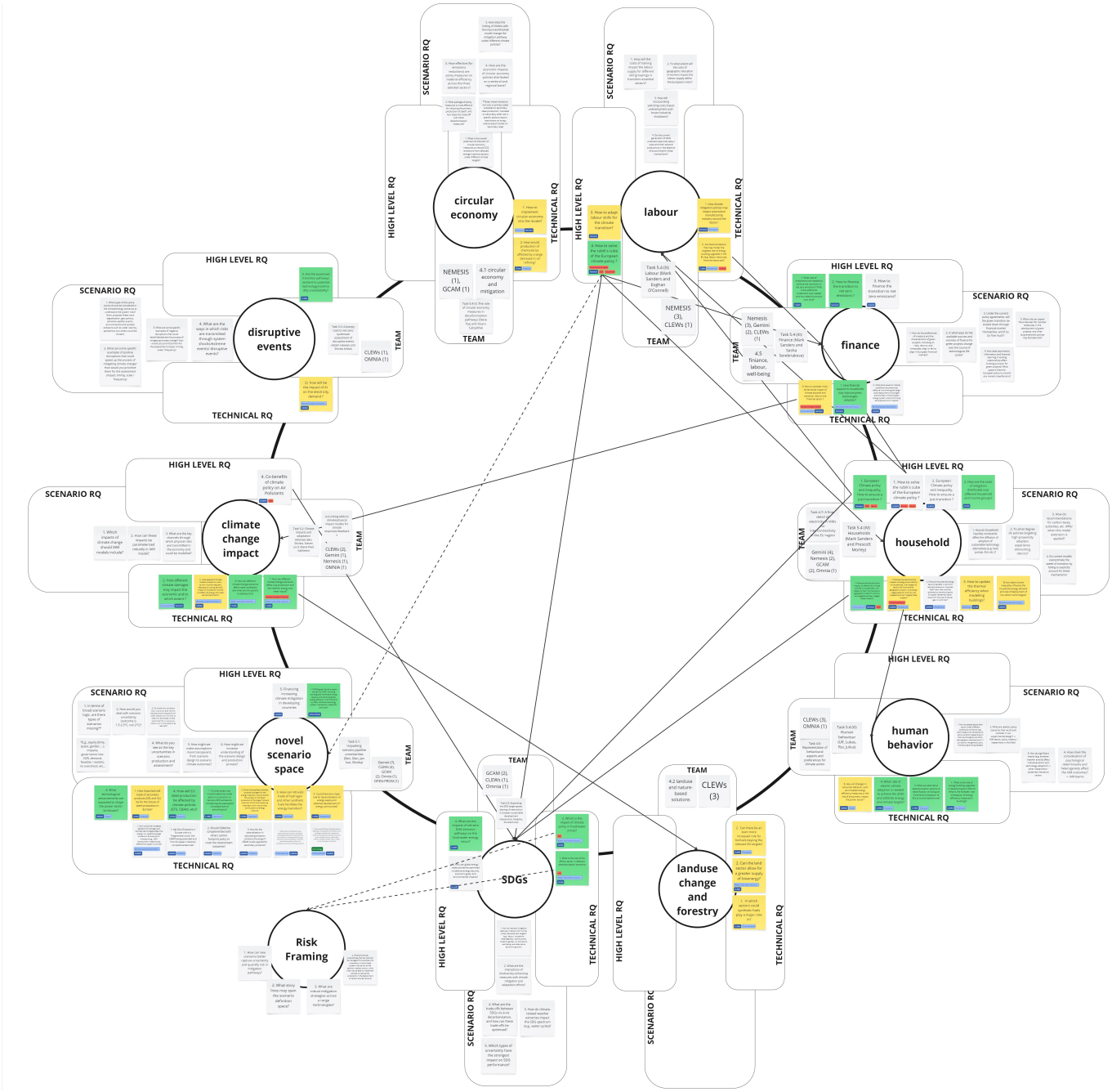

Figure 4. Schematic mapping showing the main themes and how the brainstormed research questions from partners working on IAM upgrades and on scenario expansion were organised and interconnected.

4.1.2.2 Second iteration: producing the first draft of research questions

The second iteration involved producing a draft set of research questions that integrate the data collected from the first iteration. Sticky notes and fieldnotes were collected during the workshop and digitalised on the Miro white boarding platform. Here the data was categorised and synthesised into the different themes, as shown in Figure 4. Following this synthesis exercise conducted by ETH, the experts representing each theme were asked to produce five research questions that integrated the different elements of the synthesis. At this stage, in collaboration with WP5 leads, we grouped the themes into the overarching focus groups of Climate Change, Climate Action and User-driven Scenarios based on how complimentary the different themes where.

4.1.2.3 Third iteration: co-producing research questions with stakeholders

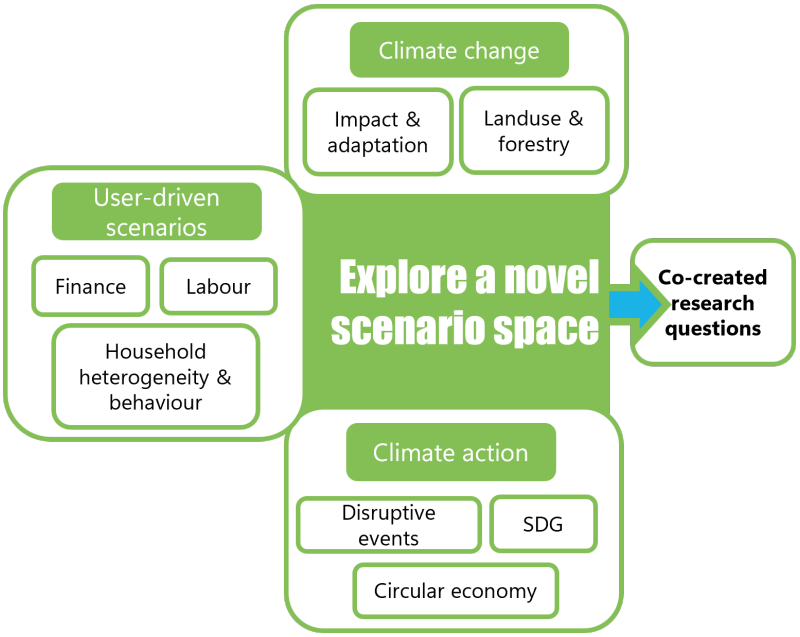

Figure 5. The three key themes and their associated topics that formed the co-created research questions

The final iteration involved stakeholders and DIAMOND partners. In total one webinar and seven workshops were held using Zoom video conferencing, Mentimeter surveys, and Google Sheets as collaborative tools. We followed ethical standards approved by the ETH Ethics Commission, and Chatham House rules applied for the webinar and all workshops.

The final iteration began with a kick-off webinar and participants were given material to read before the webinar The webinar took place in January 2025 and lasted 1.5 hours, with 52 external attendees, and served as a briefing for the workshops, in order to scope interest to participate in future workshops, as well as to collect high-level feedback from external actors on the different themes that would shape with first workshops. We shared a report with all participants containing all the feedback generated from the webinar and indicating what the next steps in the co-design process was. DIAMOND partners used this report to shape the thematic research questions that would be presented in the workshops to follow.

After the webinar, we held two rounds of workshops for each of the three groups– Climate Change Scenarios, Climate Action Scenarios, and User Driven Scenarios and the themes within those groups (Figure 5), amounting to seven workshops in total. Workshops lasted between one and two hours, with four to ten participants in each workshop. Before the first round of workshops, preparatory material containing the revised research questions was sent to the participants for each of the three groups. The workshops consisted of a presentation of the transdisciplinary process, followed by a presentation of the draft research questions. From there, a discussion group format took place, where external participants could talk about their interests, needs and perspectives that could be addressed in the revised research questions. Some techniques used in the online workshops were 'quiet time' to reflect on needs using Mentimeter; then 'individual time' to express those needs to the group; followed by an open discussion format.

After the first round of workshops, WP2 analysed the DIAMOND partners' workshop notes, and produced a report for each workshop that synthesised the main findings. These reports were used to produce the next iteration of research questions for the eight themes in the three groups. There questions were shared with the six DIAMOND IAMs teams, where they commented on the feasibility of the different IAMs addressing the research questions. Feasibility was rated between 1 and 5, and teams also left feedback to elaborate their rating.

The second round of workshops presented an Excel sheet of the research questions, their priority, and the feasibility to workshop participants. Participants were asked to validate the priority of each research question and discuss any further adjustments to the research question. This was all documented in the Excel sheet. After this second round of workshops, DIAMOND partners made final adjustments to produce the final set of research questions (Annex 1), including ranking them according to stakeholder priority.

4.1.3 Data analysis

Our Stage 3 analysis focused on developing a deeper understanding of the specific stakeholder interests in the eight themes and translating those interests into research questions that would guide scenario development and assessment. In the first and second iteration of Stage 3, before engaging stakeholders, the DIAMOND partners, lead by WP2 sought to develop boundaries around each research theme. This analysis produced ten maps each representing one of the themes that would be used to co-design research questions, for example, Circular Economy or Climate Change Impact (Figure 3).

The data analysis in the third iterations in Stage 3, when stakeholders were involved, involved consolidating, synthesising and writing up a series of reports that served as input for the next iteration of the research questions. As a final step following this deliverable, an integration workshop will take place in June 2025, to understand which research questions the DIAMOND tasks in WP3, WP4 and WP5 take forward, and how they plan to do so.

5 Findings

The findings below present the findings of the Stage 3 process to co-create a set of research questions for each of the eight themes, grouped under Climate Impact, Climate Action, and User-driven Scenarios, as well as a finding on producing novel scenarios. Each theme moves through the findings after each engagement stage. First, we present the DIAMOND team's initial focus when planning the Stage 3 stakeholder engagement – what topics they were interested in exploring, at what scale and what policies were relevant to their interests. From there, we present the findings that emerged from the multi-stakeholder discussion groups. These findings are presented for three engagement moments– the opening webinar, the first workshop, and the final workshop. Findings build on each other, with the final workshop findings getting more into technical details, compared the high-level discussion done during the opening webinar. We finalise each theme with an example of the most feasible co-created research question to address in DIAMOND that was also prioritised by stakeholders. The full list of co-created research questions for each group and its themes are presented in Annex 1. We finalise this section with findings on what stakeholders feel should shape a Novel Scenario Space, a concept being explored by WP5, and preliminarily presented in *D5.1 Novel scenario definition space*.

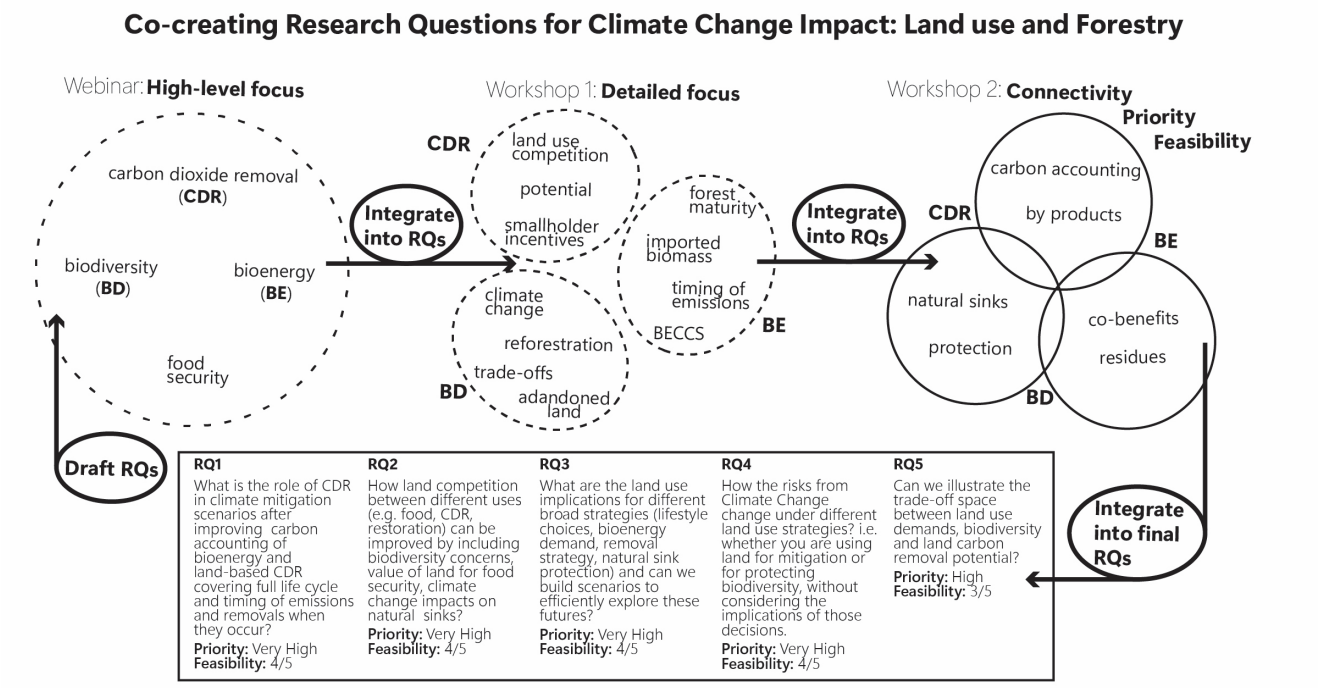

Figure 6. Land use and Forestry Research Questions: Transdisciplinary process followed to co-create research questions.

5.1 Climate Change Scenarios

The climate change group focuses on scenarios related to climate change impact adaptation and mitigation; and land use and forestry changes, specifically focusing on the missing links between the human systems and climate impacts such as unaccounted costs of adaptation and trade-offs between different land use strategies.

5.1.1 Climate Change Impact

During the planning phase of Stage 3, the DIAMOND team was interested in exploring adaptation and mitigation scenarios related to heat effects on energy demand and productivity, uncertainties of climate and carbon-fertilisation feedbacks in agriculture and forestry yields; potential impact of sea-level rise on capital stock; and adaptation measures' (e.g., agronomic, relocation, trade, grain storage) interaction with land demanding mitigation measures and address vulnerable carbon stocks. These topics are of interest across scales from national to EU and global impacts, with the national scale often focusing on the United Kingdom, due to the geographic location and area of expertise of the DIAMOND collaborators. Policies of interest included EU Strategy on Adaptation to Climate Change, UK National Adaptation Programme, Biomass strategy UK.

In the webinar, stakeholders emphasised that climate change significantly alters both oceanic and terrestrial carbon sinks, with particular attention to soil carbon dynamics. These disruptions were seen as critical feedbacks that not only affect carbon storage capacity but also have cascading impacts on broader climate system behaviour. Participants underscored the need for improved spatial representation in models to better capture how extreme events, such as droughts, floods, and wildfires, compound these effects on land systems. The conversation reflected a growing consensus that integrated assessment models (IAMs) must evolve to address these complexities with greater sectoral, spatial and temporal representation in the models.

In the first workshop, participants built on this by calling for more robust modelling of extreme climate events, particularly forest fires. Concerns were raised about the feasibility of afforestation and reforestation commitments under increasing fire risk. Fires were described as spatially heterogeneity and temporally irregularity, which presents challenges for robust representation in global models. Participants suggested integrating risk zones using historical data and environmental drivers like wind and drought to improve predictive power. This feedback reinforced the idea that capturing the influence of extreme events on the carbon cycle is essential for assessing realistic mitigation pathways.

In the final workshop, stakeholders added further technical and conceptual depth. They stressed the importance of including a wider range of extreme events, such as tropical cyclones, storms, and windthrow, in models, noting these can lead to sudden shifts from carbon sink to source over multi-annual timescales. Participants emphasised that IAMs often lack mechanisms to represent these dynamics, and highlighted existing efforts, such as Australia's FullCAM model (Richards and Evans, 2004), that incorporate fire impacts into carbon accounting frameworks. There was also a call to clarify whether gaps in modelling stem from IAM structure or calibration/data limitations, particularly with respect to how fire risk and land management interact under different climate scenarios.

On the modelling side, stakeholders noted challenges with how IAMs represent the temporal evolution of carbon uptake and the interaction between land management, soil processes, and climate drivers. Several expressed concern that achieving sufficient negative emissions from forestry and soils often requires unrealistic carbon prices in some models, raising doubts about net-zero feasibility. There was also discussion about feedbacks in soil carbon linked to vegetation dynamics, peatland degradation, and the role of climate-induced stressors in weakening forest recovery potential. Finally, a few participants called attention to missing elements, such as solar cycles, and emphasised the need to confront politically sensitive topics like geoengineering (e.g., SRM), which they argued should be proactively addressed before the narrative is dominated by vested interests.

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the European Union

Example RQ: How does soil carbon sequestration evolve over time under climate change and different management practices? How does soil carbon recover in deforested areas and changes under different forest management practices?

Priority: Very High | **Feasibility:** 5/5

5.1.2 Land Use and Forestry

The DIAMOND team was interested in improving the representation of land use and nature-based solutions in IAMs; forming scenarios of regional bioenergy production and forest CDR with associated land use emissions and costs using the land-use model MAgPIE; understanding trade-offs and synergies that may arise in the transition to global net zero such as land sparing vs land use intensification for food and energy; and farming approaches which reduce land demand while delivering sustainable, affordable, and nutritious food to growing population. These interests also span scales. Policies of interest include EU's biodiversity strategy for 2030; National Energy and Climate Plans; CAP strategic plans; the England Tree Action Plan (2021)

In the webinar, participants emphasised the growing complexity of land-use decisions under climate change, urging IAMs to move beyond simplistic carbon-neutrality assumptions and better represent the timing of emissions and removals. They called for explicit treatment of trade-offs between forestry, agriculture, and conservation, integration of biodiversity metrics aligned with global and national targets, and scenario designs that reflect lifestyle shifts and equity from the outset.

Building on this, in the first workshop, stakeholders highlighted mismatches between global IAM outputs and national reporting frameworks (e.g., NDCs using satellite data), stressing the need to harmonise definitions of anthropogenic land sinks and translate model results into country-relevant units. They highlighted land tenure dynamics as vital for sustaining local stewardship and designing incentives, and underscored forests' multifunctionality, not only as carbon sinks or bioenergy sources but also for timber, paper, and other uses, and the changing baselines where some forests now act as net emitters. Timing challenges in initial soil and forestry emissions, as well as co-benefits from biodiversity gains and IPBES-inspired transformative pathways (including degrowth/post-growth), were proposed as key modelling priorities.

In the final workshop, stakeholders then broadened the scope beyond BECCS to include a range of CDR methods and bioproducts, biochar, construction timber, biofuels, and upstream lifecycle stages in the land sector. They warned that outcomes hinge on chosen counterfactuals, which vary by region and can skew local policy if misunderstood. The role of residues in supporting biodiversity, specifically the fraction of biomass returned to soils, was identified as under-represented in models, as was the challenge of apportioning forestry carbon among end users. Critiques of life-cycle boundaries (e.g., foregone sequestration) and assumptions about abandoned land called for more realistic land-availability estimates. Attendees also urged integration of CBD and EU Nature Restoration Law commitments, flagged peatlands as special cases where renewable installations can accelerate carbon losses and pointed to the EU's cascade-use framework as a model for balancing trade-offs across carbon, biodiversity, and economic objectives.

Example RQ: How land competition between different uses (e.g., food, CDR, restoration) can be improved by including biodiversity concerns, value of land for food security, climate change impacts on natural sinks?

Priority: Very High | **Feasibility:** 4

5.1.3 Socio-Political and economical

The socio-economic and political theme first emerged in the webinar, where stakeholders underscored that land-use decisions and climate responses are profoundly shaped by social and political contexts. They called for equity to be embedded in scenario development, ensuring diverse social and economic perspectives are represented, and for models to account for how political forces and shifting societal priorities influence land-use pathways.

Building on this, Workshop 1 participants stressed the importance of incorporating realistic representations of human behaviour in IAMs. They noted that societal-level change is constrained by short-term thinking, non-rational responses, and concerns over global fairness, and that adaptation and mitigation outcomes vary with individual wealth and group identity. Stakeholders urged IAMs to capture how personal behaviours aggregate into broader social inertia or momentum, thereby enhancing the models' ability to portray authentic social transitions.

In the final workshop, stakeholders shifted focus to embedding political economy mechanics into IAMs. They advocated for richer scenario narratives that simulate populism, protectionism, and abrupt policy shifts, such as trade wars or temporary carbon-price reversals, and their effects on technology deployment and emissions. Participants recommended endogenously linking climate impacts to economic performance (e.g., GDP growth, power-plant efficiency) rather than treating them as exogenous shocks and incorporating short-term political cycles (five-year electoral terms) into model dynamics. They suggested exploring agent-based and game-theoretical methods to represent leadership changes and geopolitical risks, and emphasised the need for country-level scenarios, particularly for major emitters, to translate global results into actionable regional insights. Finally, stakeholders called for aligning IAM accounting with high-integrity GHG standards, correcting distortions like zero-rating biomass combustion emissions and including embedded emissions in clean-energy technologies, and leveraging initiatives such as SPARCCLE, IAM Compact, and ACHIEVE to strengthen stress-testing and methodological rigor.

Example RQ: Can/ Should we tailor IAM model results to enable easier comparison to Nationally Determined Contributions (NDCs) and United Nations Framework Convention on Climate Change (UNFCCCs) inventories?

Priority: Very High | **Feasibility:** 4

5.2 Climate Action Scenarios

The Climate Action group encompasses themes of Disruptive Events, Sustainable Development Goals, and Circular Economy, aiming to enhance scenarios to better reflect dynamics in these themes. The initial gaps identified by the DIAMOND group included the lack of robust modelling for disruptive events and their long-term impacts on SDGs and climate goals; and insufficient integration of circular economy practices into current Net Zero strategies.

5.2.1 Disruptive Events

Topics of interest in Disruptive Events included better representing system vulnerabilities to extreme shifts (environmental, technological, policy, societal; impacts of disruptive events on mitigation (e.g., CCS, CDR, DAC)); better defining disruptive events for climate models; and discussing the role of IAMs in simulating disruptions and developing robust strategies to cope with them. These interests varied at different scales. At a global scale, interests are around risks from pandemics and extreme weather. At a regional scale, what localised impacts should be modelled in IAMs are of interest, and at a sectoral scale, the effects disruptive events have on energy, transport, and manufacturing were of interest. Policies of interest here include Green Deal and Paris Agreement; SDGs and OECD resilience guidelines; and UNDRR frameworks for disaster risk reduction.

In the Stage 3 multi-stakeholder webinar, stakeholders emphasised the need to proactively build resilience to future disruptions, advocating for anticipatory planning rather than reactive measures. While electrification was acknowledged as a core strategy for decarbonisation, it was also seen as a potential vulnerability, particularly in politically unstable or energy-insecure regions such as Ukraine, highlighting the importance of accounting for regional disparities and justice in transition planning. Participants also noted that disruptive events can be both environmental and political, with some climate policies (e.g., aspects of the Green Deal) potentially intensifying geopolitical tensions. In this context, SDG16 was referenced to stress the importance of upholding rule of law and fairness during emergency responses, ensuring that resilience-building measures remain just and democratic even under pressure.

Stakeholders expanded on the complexity and systemic nature of disruptive events, in the first workshop, calling for models that reflect cascading effects across interconnected systems and account for regional disparities in exposure and adaptive capacity. There was strong interest in exploring how resilience strategies perform across various types of disruptions, including natural, economic, and geopolitical shocks, and in refining the very definition of "disruptive events" to distinguish acute shocks from chronic structural conditions. The destabilising potential of policy-driven disruptions and migration dynamics under stress was highlighted, as was the influence of social proximity to events on public acceptance of adaptation measures.

In the final workshop, participants delved into how to structure and govern resilience efforts more effectively. They suggested that vulnerability assessments and resilience strategies should be treated sequentially rather than conflated, and cautioned against oversimplifying complex causal chains, such as those linking climate policy to migration. The need to define clear system boundaries and model dynamic responses (learning, adaptation, and adjustment) was underscored to capture institutional and behavioural shifts over time. Beyond technical modelling, stakeholders stressed that public institutions must innovate and collaborate across traditional silos, embracing an "entrepreneurial state" approach, to implement climate adaptation systemically. They further noted that resilience frameworks should encompass non-climate disruptions (for instance, the collapse of global trade networks) and foster governance structures capable of responding to both anticipated and unforeseen shocks.

Example RQ: How do unilateral climate and trade policy actions, such as the Green Deal or trade protectionism, can lead to disruptions that influence geopolitical tensions and international cooperation?

Priority: High | **Feasibility**: 3/5

5.2.2 Sustainable Development Goals

Exploring trade-offs between SDGs and decarbonisation (e.g., biodiversity and renewables); understanding the role of energy technologies in advancing SDGs and the impact of land use and energy decentralisation on SDG11 (sustainable cities and communities) were topics of interest for the DIAMOND team exploring scenarios in SDGs. Different scales of inquiry are also taken, such as aligning NECPs with SDG targets at a European level, looking at energy scenarios to address diverse SDG challenges at a global level, and at a local level, understanding the impacts of decentralised energy and community initiatives. Policy areas of interest to the DIAMOND team included, EU Energy Directive and NECPs; Integrating SDG11 with renewable adoption; balancing mitigation with biodiversity (e.g., PV and land use considerations); and frameworks for green technology adoption at community levels.

At the webinar, attendees called for integrated assessment models (IAMs) to embed Sustainable Development Goals (SDGs) from the outset, using multi-criteria approaches rather than post-processing. They highlighted SDG15 for its emphasis on biodiversity protection and the need to align land-use and decarbonisation strategies to avoid ecological disruption. SDG16 was flagged as essential for maintaining rule of law and governance stability

during extreme events, and participants stressed that mitigation pathways must build systemic resilience by reflecting the technology–land–ecology nexus. The rising energy footprint of the digital economy was also identified as a critical factor to integrate into SDG-aligned modelling efforts.

Building on this, in the first workshop, stakeholders urged a more holistic framing of SDGs in scenario development, connecting decarbonisation to social, cultural, and ecological resilience. They called for governance scenarios under SDG16 that protect vulnerable groups, and for models to capture synergies between nature-based solutions, cultural and landscape heritage, and circular economy approaches in sectors like the built environment. SDG7 was discussed in terms of energy system stability, especially under conflict or funding shifts, and the group warned that unbounded transition costs could push countries beyond manageable thresholds, where cascading risks overwhelm mitigation. A socially grounded, equitable, and cross-sectoral SDG integration was reaffirmed as a modelling priority.

In the final workshop, participants then delved into how to operationalise SDGs within modelling frameworks, focusing on the mechanics of multi-criteria decision analysis (MCDA). They proposed exploring different SDG weightings to reveal how priorities shift trade-offs for the same disruptive event, and questioned whether a least-cost, climate-target-driven process can effectively bridge environmental objectives with broader SDG outcomes. Discussion turned to potential "game changers", both technological and non-technological, that could reshape these linkages, and to the specific interplay between large-scale negative emissions technologies (NETs) and SDG performance, noting that social acceptance remains a vital, albeit often separate, consideration. Participants also debated framing scenarios "towards a sustainable, resilient energy system" and distinguishing optimisation from constraint-based approaches to ensure models remain both ambitious and realistic.

Example RQ: How is bridging SDGs and decarbonisation at different regions affected by disruptive events and/or geopolitical shifts, and different political priorities?

Priority: High | **Feasibility:** 4/5

5.2.3 Circular Economy

Topics of interest that drove the circular economy team related to the effectiveness of circular economy policies in the steel sector; looking at synergies between material efficiency and decarbonisation; understanding decarbonisation potential of circular measures in energy-intensive sectors; and the role of technologies (e.g., DR process, CCS) in cost-effective decarbonisation. These interests also differed at different scales where a global interest lay in material shifts' impacts on energy demand and emissions. At a regional scale, the distribution of economic impacts of circular policies by region were of interest, and at a sectoral scale, looking at emissions and energy reduction in steel, cement, and other industries. Relevant policies related to these topics EU Circular Economy Action Plan (Green Deal); Low Carbon Roadmap for European Steel (EUROFER); G20 Circular Steel Initiative (IRENA); CBAM and related policies.

Stakeholders emphasised the role of circular economy (CE) principles in reducing pressure on natural resources, especially given the rising demand for wood and forest land. They noted that IAMs often overlook critical dynamics, such as wildfire impacts and feedstock sustainability, and called for scenario designs that integrate multi-objective criteria addressing both climate mitigation and resource efficiency, thereby aligning CE with broader sustainability goals beyond mere emissions reduction.

Workshop 1 participants then identified specific gaps in CE integration, notably the need to clarify who bears the financial responsibility for CE transitions and whether funding mechanisms should embed circularity conditions. Data limitations, particularly the challenge of tracking CE outcomes across territorial versus consumption-based emissions, were flagged as barriers to robust modelling. CE's role in post-disruption recovery was highlighted,

with calls to reform material-reuse regulations (e.g., in the wood sector) for greater flexibility. Finally, stakeholders underscored the necessity of international coordination, warning that national CE efforts can be undermined when circular products flow into jurisdictions without compatible standards.

Building on these foundations, the final workshop delved into model granularity and policy prerequisites for CE in forestry. Participants urged IAMs to distinguish among diverse biomass sources (forest-disturbance residues, sawmill by-products, low-value timber, and even post-consumer wood waste) and to assess which uses (bioenergy, biochar, construction materials, biochemicals) deliver the greatest economic and environmental benefits. They recommended integrating a "portfolio" view of policy levers to identify the conditions under which CE strategies can flourish. The group also questioned how circularity's definition and impacts vary across contexts, such as the differing implications of a Global North CE transition on the Global South and urged models to test sensitivity to trade-landscape shocks (protectionism, deglobalisation) and to articulate clear impact metrics (e.g., on land use, emissions, trade). This nuanced feedback aims to ensure that IAMs capture both the complexity of CE pathways and their socio-economic contingencies.

Example RQ: Are the impacts of promoting CE in industry evenly distributed across countries and regions? How can winners and losers be identified, taking into account cross-border trade and varying international alignment on circularity?

Priority: medium – high | **Feasibility:** 3/5

5.3 User-driven Scenarios

When treated as cost-benefit analyses tools, Integrated Assessment Models tend to support taking immediate action to reduce emissions rather than delaying mitigation efforts (e.g., Rebonato, 2024). While process oriented IAMs lead to cost minimising transition to <1.5 degrees, it is still unclear but how we get to net-zero. Accompanying this need, the goal for User-driven Scenario's in DIAMOND was outlined as taking IAMs from descriptive tools to prescriptive tools, formulating and simulating strategies and policy interventions to reach net-zero, where IAMs become a "digital twin" of the economy to test proposed policy interventions.

5.3.1 Labour in Transition

The DIAMOND team was particularly interested in scenarios centred on skill-specific labour demand and the mobility of workers across sectors, skill groups and regions at the national level. Policy areas of interest include (re)training policies; policy on worker mobility; education policies; and migration policies.

In the webinar, participants noted that climate change unevenly undermines labour productivity, urging IAMs to move beyond average impacts and capture variation across sectors, regions, and skill levels. There was particular interest in how SMEs navigate employment shifts and productivity changes during the green transition, and a consensus that modelling worker heterogeneity is essential. The discussion underscored that ensuring a just transition for workers and industries is both a fairness imperative and a political necessity to sustain support for climate policies.

The first workshop built on the webinar, where stakeholders drilled into labour market dynamics under different migration regimes, stressing that open, closed, or hybrid policies profoundly shape labour supply, skill availability, and mobility frictions. They highlighted acute challenges in filling transition-critical roles, with regional disparities in skill readiness and training bottlenecks slowing progress. Psychological barriers to upskilling and uneven access to training were flagged as persistent constraints. Participants called for IAMs to better capture sectoral and regional disparities and to embed targeted policies that protect low-income workers while fostering job creation and skills development in emerging green sectors.

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In the last workshop, stakeholders emphasised the need to model both supply- and demand-side labour dynamics to quantify labour's added value in the transition. They proposed using labour productivity as a key sector-level metric from a user perspective. Migration emerged as a critical yet under-investigated factor: while modelling migration flows remains challenging, participants recommended developing migration scenarios in IAMs, especially for refugee movements, and exploring how these inflows affect labour supply and demand. They also pointed out the absence of feedback loops in current scenario designs and urged development of approaches that endogenously connect migration decisions with productivity and employment outcomes.

Example RQ: How does labour migration interact with climate change's effect on labour productivity to speed up or slow down the energy transition?

Priority: Medium High | **Feasibility:** 2/5

5.3.2 Finance in Transition

Share of capital costs, level of capital cost, risk and uncertainty, and duration and the maturity of financial products were highlighted as important topics to cover in scenarios related to finance in the transition to net-zero emissions. Regarding dimensions of heterogeneity, the team extended their interest beyond only geography but also technology and investor types. Here policies and institutions of interest were institutional and private investors; public guarantees; blended finance policies; fiscal policy; and monetary policy.

In the webinar, stakeholders highlighted the need for careful interpretation and communication of IAM outputs in financial decision-making, warning against their misuse in areas like pensions and transition risk. They noted a tendency among some actors to favour strategies aligned with higher warming scenarios rather than finance more ambitious climate transitions, underscoring strategic reluctance that could impede progress. Participants called for IAMs to broaden their financial perspectives, especially by including asset owners, and to capture how climate resilience, competitiveness, and financial institutions interact to enable or constrain climate action.

The first workshop emphasised moving beyond static assumptions of seamless global markets by incorporating geopolitical fragmentation and regional cooperation into scenario spaces, recognising their influence on capital flows and availability. Attendees stressed that while cost of capital matters, practical constraints, such as infrastructure bottlenecks and material shortages, often pose greater limits on investment. They urged IAMs to become more sector-specific (e.g., green mobility, clean energy), integrate with financial tools like credit assessments and asset valuation frameworks, and embed tailored risk-return profiles that reflect grid capacity, supply-side risks, and technology adoption delays.

In the final workshop, participants shifted focus to the use cases of finance in IAMs, prioritising how financial insights drive decision-making over merely improving financial representations. They stressed distinguishing between government versus private funding, and between EU-based and global investment pools, to reflect diverse capital sources. The maturity of a technology was identified as the primary determinant of appropriate financing instruments (private equity, loans, listed equity), with large investors dominating private markets and smaller investors often sidelined. Insurance companies' preference for short maturities and pension funds for long ones highlighted the need to model varying risk-horizon preferences. Across all sources of capital, policy (un)certainty emerged as the key factor shaping investor confidence, with participants urging IAMs to represent how shifting policy landscapes influence return expectations and risk assessments.

Example RQ: How do real economy bottlenecks, risks and constraints, affect risk-return profiles across asset classes? **Feasibility:** 4/5

5.3.3 People in Transition

Topics of interest for scenarios focusing on human behaviour, and household heterogeneity included: adoption of green technology and green practices; emissions of consumption; emissions in residential sector; information cascades; preference drift and dynamics; and credit and liquidity constraints. These topics were of interest on a household and network scale, and at regional and national geographic scales, and also on a technology scale. Policies and mechanisms of interest are traditional carbon taxes & subsidies; public procurement; information campaigns; consumer credit; and income &/or wealth redistribution mechanisms.

Stakeholders stressed the importance of capturing heterogeneity across households and firms – particularly SMEs – as these differences shape how various actors experience and adapt to green transitions. Differences in capacity, skill needs, and behavioural responses all influence resilience and competitiveness under climate change. Participants emphasised that IAMs should incorporate lifecycle dynamics and behavioural insights to reflect how demand patterns, consumption habits, and production systems evolve, enabling more realistic and inclusive modelling of socio-economic transitions.

In the first workshop, participants highlighted the role of psychosocial drivers, such as cognitive dissonance, denial, and income constraints, in shaping green-technology adoption, noting that extreme events can trigger rapid shifts in public opinion that IAMs rarely capture. They flagged equity issues in policy incentives (e.g., electric-vehicle subsidies favouring wealthier households) and urged models to reflect regional differences in infrastructure, education, and social acceptance. This richer behavioural framing was deemed essential to design fair, effective transition strategies.

In the last workshop, stakeholders refined the focus on household heterogeneity by distinguishing two analytical strands. Firstly, diffusion patterns, which examine how technologies and behaviours spread across socio-demographic groups; and secondly, impact tracking, which measures how specific policies affect different household types – information crucial for both policymakers and investors. They also called for clear delineation of who develops and implements behavioural strategies (public vs. private actors), and noted that sector-level labour and skills shortages link household adaptation to broader economic impacts. From an investor perspective, detailed insights into which sectors and regions face skill gaps or heightened transition risks were deemed key. Finally, participants urged IAMs to clarify how sociological, psychological, and economic dimensions interrelate, ensuring models can test targeted education, communication, and incentive mechanisms to accelerate equitable adoption of green technologies.

Example RQ: How do extreme climate events influence public perception and social acceptance of green mobility and clean energy technologies over time? **Priority:** High | **Feasibility:** 4/5

5.1.1 A novel scenario space

Across several the different groups, participants stressed the need to broaden the scenario space used in integrated assessment and transition modelling to better reflect plausible, complex, and regionally diverse futures. Similar to conversations that happened in the climate impacts and land use and forestry sessions, participants in the finance, labour, and household behaviour groups echoed the need for scenarios to move beyond idealised assumptions about well-functioning global markets, linear transitions, and uniform policy uptake. They called for scenarios that include short-term timelines (recognising that five years can already bring major changes), extreme climate events, realistic climate and macroeconomic spillovers, and disruptive transitions shaped by political and infrastructural constraints.

Stakeholders emphasised that scenario development should account for a wide range of uncertainties—including who pays (households, states, or businesses), the strength of climate feedbacks, varying levels of social acceptance

and behavioural uptake, and resilience capacities across populations. Participants also pointed to transformative change pathways, such as those explored by IPBES, and advocated for revisiting high-end warming scenarios like RCP 8.5, especially in the light of worsening emissions trends and persistent political and implementation delays. Geoengineering options (e.g., solar radiation modification) were also raised as necessary, if controversial, elements to consider in a full-spectrum scenario space.

Realism in economic and political assumptions was another recurring theme. Modellers were encouraged to represent real-world bottlenecks, such as labour shortages, training lead times, grid capacity, and policy inertia, that shape the pace of change. The importance of reflecting sectoral heterogeneity was also highlighted: for example, while EV transitions may move quickly, deep retrofits in the building sector progress much more slowly. Participants warned against over-relying on carbon pricing mechanisms or assuming smooth transitions, urging instead for scenarios that reflect contested transitions, varying degrees of public support, and the presence (or absence) of a "social license to operate."

Participants called for models to serve user needs more effectively. Governments require insights into what's realistically achievable under different conditions, including the potential role of taxation and policy sequencing in accelerating change. Financial actors, particularly investors and credit agencies, need concrete, sector-specific information and better integration of risk-return dynamics into scenario design. In all cases, improving transparency around trade-offs, such as those between speed, cost, and equity, was seen as essential.

Finally, stakeholders stressed the need to align scenario narratives with the policy definitions and metrics used nationally, to ensure model outputs are clearly translatable across governance and sectoral contexts. This includes modelling equity outcomes, behavioural dynamics, and feedback loops, not only to enhance realism but also to improve political and institutional robustness of proposed pathways.

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6 Discussion & Conclusions

This conclusive discussion reflects on the transdisciplinary approach undertaken in Phase 1 of DIAMOND's WP2: Codesign, particularly the collaborative formulation of research questions that guide model and scenario development. While joint problem framing a valuable approach to stakeholder engagement in modelling, our findings reveal that co-production must extend beyond formulating research questions to shaping how they are interpreted and addressed. The workshops also navigated tensions between model-driven constraints and stakeholder-driven priorities, exposing the risk that technical limitations may override societally relevant concerns. In this final section we elaborate on four main components of the transdisciplinary process we have developed in Phase 1. We examine how co-produced research questions are shaped by stakeholder perspectives and model capabilities; the need to translate findings across themes; and the implications of applying transdisciplinary principles in integrated assessment models (IAMs). We conceive of these as the main areas in which TD research has proven relevant to achieve DIAMOND's aims. These reflections aim to support more inclusive, transparent, and actionable pathways for transdisciplinary modelling in climate and sustainability science.

6.1 Transdisciplinary research approach into IAMs

Methodologically, Phase 1 of DIAMOND's co-design approach focused on co-producing research questions using a transdisciplinary approach. The approach has proved to be successful in understanding the key topics of concern across the different themes that are being researched in DIAMOND, moving beyond mere consultation with a diverse group of stakeholders. In WP2, we took a deliberate choice towards collecting stakeholder concerns despite model limitations to address those concerns. This approach ensured that research questions present and reflect gaps and limitations in models. As we have detailed in this deliverable, the transdisciplinary approach has allowed to integrate a heterogeneous set of questions and expectations, many of the questions are not easy to address, some may only be partially addressed, and others would not be possible to address at all – serving as opportunities for further future research. Therefore, following a careful and transparent integration process in Phase 2: Co-production, is vital to ensure that the research questions are guiding scenario development while remaining transparent about the degree to which the research question was addressed and what modelling limitations were presented. A major focus for Stage 3 was to ensure that stakeholders remained invested throughout most engagement activities. The process of gathering stakeholder names and retaining participation throughout Stage 3 required a high and continuous investment of time, which is a fundamental stage in the transdisciplinary process. This proved to pay off, with a good attendance on the kick-off webinar, as well as enough participants being interested in contributing to the workshops that followed which required some continuous commitment on their end. The transdisciplinary approach detailed here requires a high level of commitment not only from the leading team, in this case ETH, but also from partners and selected stakeholders. This has been achieved as the foundation to deliver results in different related WPs in DIAMOND, such as WP3, WP4 and WP5.

6.2 Joint problem framing: beyond research questions

Much of the focus in the multi-stakeholder discussion groups was not only around shaping the research questions, but also around understanding methods of analysis, or the boundaries within which to consider the research questions – what factors should researchers consider when addressing these questions in scenario development? Therefore, it is not sufficient to only have coproduction with stakeholders in formulating research questions, but also in shaping the conditions under which the research questions are answered. However, during the co-design process it also became clear that some questions are driven by the models' gaps, limitations and capabilities, rather than based only on inquiries into a specific theme. While it is very important to acknowledge the limitations

of IAMs, we felt that an overemphasis on models while developing research questions could potentially compromise integrating the important components that would result in research questions that are societally relevant. However, this approach means that some of the co-designed research questions will be challenging to model, and that another layer of transparent feedback is shared with stakeholders who participated in the workshops on how these questions are taken forward. Such feedback will be shared after the integration workshop in June 2025 where DIAMOND partners will elaborate on which questions to take forward in the different tasks.

6.3 Translating findings across themes and contexts

Another main area of relevance related to integrating detailed stakeholder input into research questions is translating co-produced knowledge across topics. For example, while stakeholders were largely interested in wood in CE, DIAMOND's focus in CE is mainly oriented around the steel industry. Therefore, it is important to understand whether there are certain overarching principles for CE in the wood industry, that can be translated to CE in the steel industry to address important CE concepts in scenario development. This way of translating feedback between topics, can ensure that feedback from stakeholder groups is considered, and even understood at a more conceptual level, which may be useful when understanding broader stakeholder needs in scenario development and assessment.

Themes were also found to be highly interconnected, showing the importance of integration across the Climate Change, Climate Action, and User-driven Scenarios groups. For example, while dealing directly with wood in the Circular Economy theme might be difficult, the findings could be useful for the Land use and Forestry theme, where considering Circular Economy measures may result in valuable insights for in adaptation and mitigation strategies in Land use and Forestry.

6.4 How stakeholder-informed research questions are answered

Some research questions can be addressed in the models but only stylistically, rather than including specificities that stakeholders had mentioned in workshops. For example, the highly localised nature of land use and forestry does present a limitation for models to represent just localised specificities. This might not be in line with stakeholders' expectations, who may think that research questions are being partially addressed and that the results are not as useful as they had hoped. Scenarios based on IAMs have generally been used to answer broad questions about trade-offs in different mitigation strategies. For example, how does short-term action influence long-term action. However, the stakeholder-informed research questions demonstrate that users need much more granular and actionable information, which may push models to their design limits.

On the one hand, the question will ultimately arise if one should develop a 'super model' that attempts to address all research questions and interactions, or whether models should be developed or adapted to address specific questions only. The pathway to develop models, or model portfolios, that can adapt to and provide the granular information desired by stakeholders will be an increasingly important discussion. On the other hand, one can question whether the roles of models should be to answer such specific questions, or whether addressing such specificities should be done by accompanying quantitative and/or qualitative methods that are able to layer in the specificities and uncertainties that IAMs are not able to deal with.

6.5 Concluding Remarks and next steps

The output of this process came in three levels. First, we developed a synthesis of the co-produced knowledge for each of the eight themes that highlight the key topics to focus on in scenario development and assessment. Second, we co-created 41 research questions that guide model and scenario development, assessed the feasibility

of models addressing these questions and assessed the stakeholder priorities of each question. Finally we provided some high-level reflections of the co-produced knowledge such as the importance of stakeholder input beyond the research questions themselves; the importance of transparency on how exactly research questions are dealt with in scenarios and model runs; and finally, how we can translate some findings across the different themes and contexts to also inform our higher level conceptual thinking in scenario development and assessment. We reflected on the value of using a transdisciplinary process in IAMs and acknowledged the time necessary to carry out such a process.

Transdisciplinary modelling offers an opportunity to build upon participatory modelling, adding open and reflexive elements that codesigns and coproduces the enquiries that models and scenarios address, increasing IAM relevance, co-ownership and uptake of results into policy recommendations (Jäger et al. 2023), which is an aim of the DIAMOND project. As the next step in DIAMOND's WP2: Codesign, we move to *Phase 2: Toward co-production*. Our first step in this new phase is an in-person workshop with DIAMOND partners in June 2025, to assess the research questions, and understand which questions can meaningfully be taken forward and in which DIAMOND activities. We will communicate the workshop output to all the stakeholders that participated in co-creating the research questions. This ensures transparency and also manages expectations on the kind of results models can produce, and how these results may be useful for policy and practice. Our Phase 2 will be concluded in month 36, (November 2025), resulting in *Deliverable 2.6 Synthesis of co-produced knowledge*.

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Annex 1: Stakeholder-informed research questions

Climate Change Scenarios		**Stakeholder priority:** L= Low, M= medium, H= high, VH= very high **Model feasibility:** 1= unfeasible, 2= major adjustments, 3= adjustments, 4= minor adjustments, 5=no adjustments			
Climate Change Impact	How does Climate Change change the frequency and intensity of forest fires, and how this affects land carbon stores and land use strategies? H/3	How does soil carbon sequestration evolve over time under climate change and different management practices? How does soil carbon recover in deforested areas and changes under different forest management practices? VH/5	How does climate change affect ocean sinks? M/1	What is the role of solar radiation management in the mitigation scenarios? L/1	
Land Use and Forestry	What is the role of CDR in climate mitigation scenarios after improving carbon accounting of bioenergy and land-based CDR covering full life cycle and timing of emissions and removals when they occur? VH/4	How land competition between different uses (e.g., food, CDR, restoration) can be improved by including biodiversity concerns, value of land for food security, climate change impacts on natural sinks? VH/4	What are the land use implications for different broad strategies (lifestyle choices, bioenergy demand, removal strategy, natural sink protection) and can we build scenarios to efficiently explore these futures? VH/4 How the risks from Climate Change change under different land use strategies? i.e., whether you are using land for mitigation or for protecting biodiversity, without considering the implications of those decisions. VH/4	Can we illustrate the trade-off space between land use demands, biodiversity and land carbon removal potential? H/3	
Socio-Economic and Political	Exploration of regional dynamics of resources utilisation (fossil/renewable/capital) under different policy futures. H/4	How considering climate change impacts on resources (natural, man-made, population) influences the socio-economic characteristics of the pathways to net zero? VH/3	How do we represent geopolitical shocks/shifts in policy feasibility? H/4	Can/ Should we tailor IAM model results to enable easier comparison to NDCs and UNFCCC inventories? VH/4	Can IAM carbon accounting practices align with the GHG Protocol/other accounting practices? H/1

Climate Action Scenarios		**Stakeholder priority:** L= Low, M= medium, H= high, VH= very high **Model feasibility:** 1= unfeasible, 2= major adjustments, 3= adjustments, 4= minor adjustments, 5=no adjustments				
Disruptive Events	What economic and geopolitical vulnerabilities emerge from electrification and low-carbon transitions, and how can resilience strategies contribute in reducing supply	How do unilateral climate and trade policy actions, such as the Green Deal or trade protectionism, can lead to disruptions that influence geopolitical tensions and international	How can scenario-based modelling capture cross-sector disruptions from climate and policy shocks, and evaluate sector-specific responses over time? H/3	How can circular economy and nature-based solutions enhance resilience against resource supply chain shocks and infrastructure disruptions? M/3	How can institutional innovation and cross-sector collaboration enhance resilience to cascading disruptions and reduce the risk of systemic crises? H/2	How can SDG16 principles strengthen institutional resilience and ensure equitable governance during cascading disruptive events? H/1

	chain disruptions and economic instability? H/3	cooperation? H/3				
Circular Economy	What is the potential of CE in the wood industry by sustainably utilising biomass from forestry disturbances (e.g., fires, pests, and diseases), production residues and post-consumer waste? What policies would be most effective in unlocking this potential? M-H/3	What actions should governments, industries, financial institutions, and international organisations take to foster the CE, particularly in relation to financing and embedding of CE principles into international trade and investment decisions? M-H/3	Are the impacts of promoting CE in industry evenly distributed across countries and regions? How can winners and losers be identified, taking into account cross-border trade and varying international alignment on circularity? M-H/3	How can disruptive events such as natural disasters create opportunities to implement CE practices through the recovery and reuse of waste materials? M-L/3		
SDGs	How is bridging SDGs and decarbonisation at different regions affected by disruptive events and/or geopolitical shifts, and different political priorities? H/4	What is the role of technologies (e.g., NETs and other game changing including non-tech innovations) and social acceptance in the interplay between land use, biodiversity preservation, and mitigation, and what are their broader SDG implications? M-H/4	Which technologies or transformations (e.g., digital economy) contribute the most towards a sustainable, resilient energy system, in the light of extremes and shocks? M/4	What is the interplay between SDG13 and SDG15 (i.e., what is the impact of mitigation on biodiversity preservation, and vice versa, of biodiversity preservation on the climate system), and what are broader benefits. H/2	Which SDG-15-related actions and constraints should be quantified and imposed on IAM scenarios? M/3	

User-driven Scenarios		**Stakeholder priority:** L= Low, M= medium, H= high, VH= very high **Model feasibility:** 1= unfeasible, 2= major adjustments, 3= adjustments, 4= minor adjustments, 5=no adjustments				
Labour in transition	How can we model and calibrate skill supply dynamics by demographics and region? M/4	How can we model and calibrate labour demand dynamics by sector, technology and region? M/4	How does climate change impact labour productivity across sectors and skill levels? H/2	How does labour migration interact with climate change's effect on labour productivity to speed up or slow down the energy transition? M-H/2		
Finance in Transition	How do we model and calibrate the investment demand dynamics by technology and risk-return profile? 4	How do we model and calibrate the intermediation of savings to investment through financial instruments? 1	How do real economy bottlenecks, risks and constraints, affect risk-return profiles across asset classes? 4			
People in	How can integrated	What strategies can	What role do	How can policies	How are certain	How do extreme

Transition	assessment models (IAMs) better account for household heterogeneity in forecasting green technology adoption? And how can this enable them to better represent a wider range of policy options? H/4	enhance resilience to climate change and transition impacts across different households? M/3	psychological factors play in the adoption of green technologies, and how can policies take this into account? M-L/4	reduce disparities in the adoption of green technologies, stemming from variations in household characteristics? M/3	sectors impacted differently by shifts in energy demand and production? M/4	climate events influence public perception and social acceptance of green mobility and clean energy technologies over time? H/4

Annex 2: List of Contributors*

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