USING ROBUST DECISION-MAKING TO DEVELOP LONG-TERM STRATEGIES

A Practical Guide

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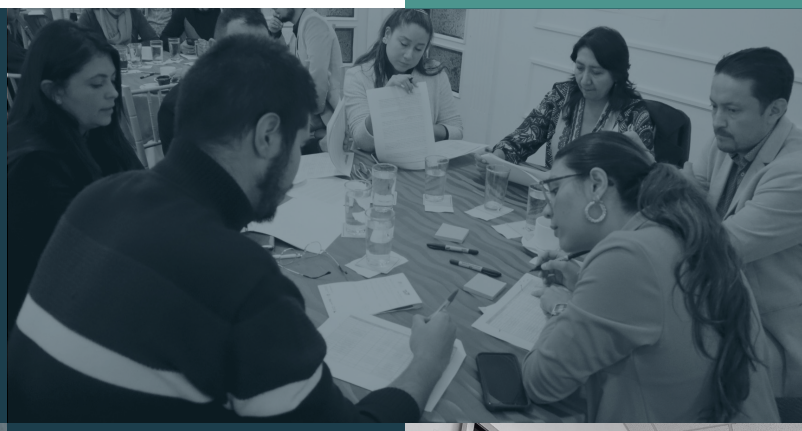

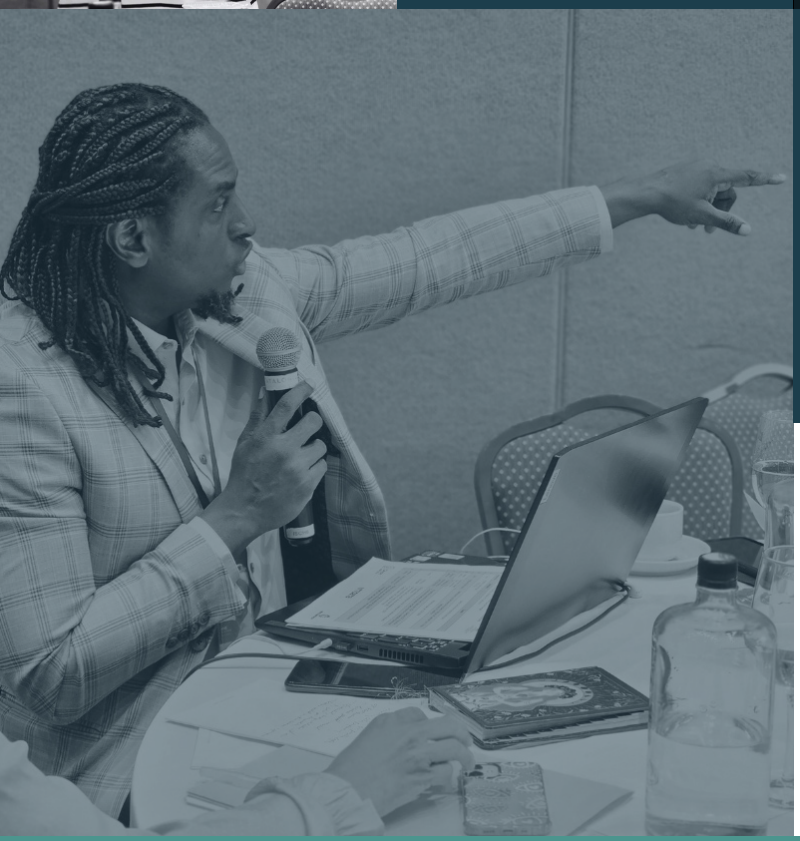

Climate Lead Group

2050 PATHWAYS PLATFORM

ACKNOWLEDGMENTS

This report was written by Jairo Quirós-Tortós, Luis Víctor-Gallardo, Mariana Rodríguez-Arce, and Alejandra Soto-Rodríguez.

The final edition and design were carried out by Mina Lee and coordinated by Saskia Geurtzen.

This project was supervised by Marcela Jaramillo.

We sincerely thank the 2050 Pathways Platform for supporting and collaborating on this project. Their contributions were instrumental in advancing this guide.

We greatly appreciate the valuable comments from reviewers Adrien Vogt-Schilb, David G. Groves, Marcela Jaramillo, and Mark Howells.

We also acknowledge the numerous experts, stakeholders, and participants whose active engagement enriched our efforts. As we unite our expertise in science and policy, we are forging a path towards a more sustainable and resilient future.

We thank all colleagues who participated and contributed to the workshops for the preparation of this document (in alphabetical order): Adrien Vogt Schilb, Carlos Benavides, Chadia Abreu, David Groves, Diego Quishpe, Edgar Enrique Miranda Sandoval, Edmundo Molina Pérez, Esperanza Gonzalez Mahecha, Fernando Granizo, James Syme, Jose Manuel Sandoval, Juan Sebastián Proaño Avilés, Lorena Córdova, Luis Rodrigo Leonardo Castellanos, Marco Vinueza, Maria Valdiviezo, Mark Howells, Mario Salgado, Pablo Ferragut, Rafael Soria, Sandra Barriga, Sarah Achaichia, Sebastian Vicuña, Steve Pye, Steven Popper, Valentina Saavedra Gomez, Veronica Guayanlema, and William Usher.

About Climate Lead Group

Climate Lead Group provides state-of-the-art consulting services rooted in data and rigorous research, driving sustainable development and climate action. Climate Lead Group collaborates with public and private institutions at the local, national, and international levels, assisting in identifying and implementing sustainable solutions to energy and climate challenges. Climate Lead Group brings a wealth of experience in innovative research, training, and project implementation, having coordinated and executed over 20 projects in collaboration with multiple government agencies and international organizations.

About 2050 Pathways Platform

The 2050 Pathways Platform is a government and multi-stakeholder initiative launched at COP22 by then High-Level Climate Champion and architect of the Paris Agreement, Laurence Tubiana. It was established at the request of countries that wanted a “big tent” approach to 2050 long-term climate strategies. In addition to governments, it brings together a network of bilateral and multilateral donors, international and national think tanks, as well as climate policy experts with an interest in long-term planning in response to the climate crisis.


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1 INTRODUCTION

As the world grapples with the urgent need to stabilize the climate within the thresholds of 1.5 to 2°C above pre-industrial levels set by the Paris Agreement (Paris Agreement, 2015), the quest for net-zero greenhouse gas (GHG) emissions by mid-century emerges as a pivotal challenge. The Intergovernmental Panel on Climate Change [IPCC, (IPCC, 2023)] underscores the imperative of achieving net-zero GHG emissions by 2050 to avert the most catastrophic impacts of climate change. However, GHG emissions sources are linked to almost all economic activities, making abrupt reductions difficult.

Long-Term Low-Emissions Development Strategies (LT-LEDS or in short LTS) represent a pivotal component in the global response to climate change, serving as comprehensive frameworks that nations are adopting to map out their transition to net-zero emissions. With over 100 countries having pledged to achieve net-zero emissions, the development and implementation of LTS are crucial for orchestrating the profound and systemic changes required across all sectors of the global economy. These strategies are not only about reducing GHG emissions; they encompass a broader vision of sustainable development, economic transformation, and social equity (Calcufoy et al., 2022).

Although environmental ministries often lead the charge in making and operationalising these commitments, other actors, including companies, households, and government agencies, spanning energy, agriculture, and forest (Fazekas et al., 2022) are also involved. While there may be a general alignment with climate change mitigation goals, these diverse actors also pursue a wide array of objectives that may not always converge with environmental targets.

The path to net-zero is fraught with complexity and uncertainty. The horizon of 2050 extends far into the future, introducing a spectrum of uncertainties that complicate planning and decision-making, such as: the costs of technologies and commodities may

vary significantly from current estimations, social behavior may affect demands for different goods and services, and political goals may change as government cycles occur every four to five years. Addressing such multifaceted challenges, with their blend of actors, objectives, and uncertainties, calls for innovative and adaptive approaches.

Here, **Robust Decision Making (RDM)** emerges as a potent tool (Marchau et al., 2019). RDM transcends traditional decision-making frameworks by engaging stakeholders in defining objectives, exploring a wide array of uncertainties, and crafting strategies that remain effective across various possible futures (Lempert et al., 2003). This approach prioritizes flexibility and resilience over reliance on a single goal or scenario, making it particularly suited to the dynamic and complex nature of climate change mitigation efforts.

RDM has already shown its efficacy in climate-related planning, such as adaptive water management (Miro et al., 2021), and it is increasingly being applied to develop LTS aimed at achieving net-zero emissions. A notable example includes Costa Rica, where a comprehensive cost-benefit analysis, supported by RDM, outlined sectoral changes and associated benefits (Groves et al., 2020), as well as a fiscal study demonstrated policy options to effectively manage fiscal concerns linked to transport decarbonization (Rodriguez et al., 2022). This success story has inspired similar initiatives in Peru (Quirós-Tortós et al., 2021), Chile (Benavides et al., 2021), Colombia (Arguello et al., 2022), the Dominican Republic (Quirós-Tortos et al., 2023), and ongoing efforts in Panama and Guatemala.

This guide distils lessons learned from these experiences, drawing from academic research, stakeholder insights, policy development, and financing strategies to support governments, donors, and consultants in mobilizing RDM for LTS design. These examples show how RDM aids governments in developing resilient long-term strategies. A key objective of a robust LTS is to inform action in the short term such as, on policies and public investment priorities across sectors. Additionally, the adoption of RDM in creating long-term policy strategies can play a significant role in informing or updating Nationally Determined Contributions (NDCs) and creating or revising national development plans. In fact, the United Nations Framework Convention on Climate Change (UNFCCC) asks countries to align their NDC and LTS, which requires transparent data sharing and flexible tools that can help inform milestones over time towards reaching the net zero goal.

The guide presents a detailed 10-step process to deploy RDM in countries or regions, covering everything from initial planning to final reporting. Its aim is not only to navigate the complex terrain of climate change mitigation but also to foster a collaborative, inclusive, and forward-looking approach to crafting strategies that can withstand future uncertainties.

In the age of unpredictability, RDM emerges as a beacon of adaptability and resilience, essential for sustainable development and climate action. This guide aims to equip decision-makers globally with the tools to build a sustainable, resilient future, and to be a valuable resource for practitioners of long-term planning worldwide. By embracing the principles of RDM, stakeholders can collectively define a vision for a net-zero future, tailor transitions to local contexts, and prioritize actions that ensure resilient and sustainable outcomes.

2 PRACTICAL GUIDE

This section provides a comprehensive guide on deploying the RDM methodology to support your project. Each subsection delineates the **activities and tasks** tailored for three distinct roles that are commonly present in the process of LTS development: Government, Founder, and Implementer. It is important to note that while the guidance provided for each of these roles reflects experiences and best practices, there can be flexibility in the scope of the roles to better respond to your country or project context, for example, countries are looking to building implementor capacity beyond academia and have this within the government agencies. Following that, we highlight the main **products** generated from each step. This guide uses insights from prior regional projects to illustrate every step with **practical examples** and share useful **tips** to enhance the effectiveness of the process.

Step 1: Project set up

The first step is a starting point in shaping the project's trajectory. It centres on articulating the climate and socio-economic goals in a national LTS, and determining the budget, funding sources, resource requirements, teamwork, and the Terms of Reference (ToRs).

Activity 1.1: Define the key objective of the national LTS

RDM can address science-based policy questions specific to key objective(s) set out in an LTS. In the context of climate policy, governments often seek answers to questions like: *What transformations are necessary to achieve net-zero carbon or GHG emissions by mid-century while also bringing socioeconomic benefits to society?*

From a strategic planning perspective, uncertainties – such as technological advancements and policy changes – play a critical role. Governments frequently ask: *How do these uncertainties impact net-zero emissions goals and the associated socioeconomic benefits?*

While the specific queries may vary per country, the underlying principle remains consistent: Governments want to explore pathways to reach net-zero emissions while maximizing benefits.

To formulate the key objective of the national LTS and the underlying policy questions that needs to be addressed through RDM, frame them within a broad context. This allows for the natural evolution and refinement of these questions through the initial stages of the process. Ideas and concerns from national stakeholders will help shape the questions and bring forward innovative solutions. This dynamic and inclusive aspect of RDM ensures that the resulting strategies are robust and aligned with the diverse needs and perspectives within a country.

This activity should also ensure alignment with other key national policies, such as national development plans and shorter-term climate related strategies such as the NDCs.

Activity 1.2: Develop the ToR and determine budget and resource requirements

Creating the Terms of Reference involves outlining a comprehensive framework that encompasses a country-specific background, detailing existing initiatives, visions, funder support, and prior experiences alongside regional benchmarks. The ToR should define the project's scope clearly, addressing the key objective to deliver an LTS through specific tasks and deliverables, and include capacity-building

measures for local teams and government counterparts to ensure the LTS remains adaptable to future changes.

The work scope should emphasize the implementer's role, typically a consulting firm or research centre, in supporting the government and diverse stakeholders to forge a vision and pathway that harmonizes environmental resilience with economic development. The scope also mandates building upon existing environmental efforts, incorporating data analysis, scenario modelling, and uncertainty analysis to draft resilient and robust sector-specific low-carbon pathways.

Capacity building is crucial to equip stakeholders with the necessary skills for LTS implementation, risk management, and strategy adaptation. The ToR should provide details in the expected requirements for formulating the LTS, including milestone setting, advice on sectoral compromises, governance reforms, financial planning, and integrating the LTS into broader national frameworks.

Work packages, a set of activities designed to reach a specific goal within the project that contributes to the ultimate objective and structured to facilitate project management, should include visioning and stakeholder engagement, modelling and analysis, capacity building, and strategy formulation, with timelines for each phase to ensure timely project progression and effective LTS development. The work package could follow the structure of the following 9 steps in this guide.

Proper resource estimation goes beyond simple budget allocation, necessitating a thorough understanding of specific needs, timing, and potential funding avenues. Evaluate whether existing analysts, data, workflows, and computer models suffice or if there is a need for developments or extensions of new resources– each carrying distinct budgetary implications and timelines.

Activity 1.3: Structure the project team

For successful implementation, assemble a team that is well-versed in RDM methodology. The objective of the process is to deliver a policy-relevant LTS. To achieve that, the team should include individuals capable of managing projects effectively, developing and adapting tools, engaging stakeholders through participatory approaches, and conducting detailed policy analysis through modelling. Additionally, sectoral experts and economists are essential for providing in-depth knowledge and estimating impacts relevant to the project's goals.

While roles may overlap, with some individuals taking on multiple responsibilities, the emphasis should be on leveraging local expertise and capacity. This approach ensures the alignment of the project with national and sectoral realities and supports the development of local capabilities, as demonstrated in countries like Costa Rica and Guatemala. In summary, prioritize the selection of team members with RDM expertise and local experts to facilitate a robust and adaptive project execution.

The team goes beyond the analysts. It should also include a coordination team, which will serve as the interface between the analytical work and policymakers, and are responsible for ensuring coherency across planning exercises and the LTS, including, for example, to enable linkages with the NDC update process. The project team should also include government counterparts. They are responsible for providing the political steering of the process. This includes securing the necessary audience for workshops and bilateral meetings, and must ensure that key actors are involved in the co-creation process. They are in charge of approving products and milestones as well.

Additionally, the project team should comprise of technical peers within the funder institution. Typically, the funder will involve sectoral experts that can support the LTS development while providing technical expertise to the process, which will help secure realistic and achievable transitions to net-zero goals. For example, in Costa Rica, the Climate Change Directorate led the discussions and served as the coordination, the Interamerican Development Bank team provided funding and technical expertise, advising in best practices and showcasing experiences from similar RDM implementations to develop an LTS in other countries, the local university developed models and scenarios to inform the pathways to net-zero, and expert policy advisors with local expertise supported the drafting process, to bring technical and policy discussions into a single LTS document.

It is advised to establish a regular meeting cadence as RDM is a dynamic methodology requiring a flexible approach. Consider organizing regular (e.g., biweekly) meetings with the government, funder, and implementer to ensure the analyses continues to match with the expected outcomes.

Key tasks by role:

Government	• Seek local expertise. • Hold meetings with the funders to define the research question.
Funder	• Help the government with identifying the best policy and investments at concrete scales. • Set the rules and scope of the project for funding, considering the country context needs. • Hold meetings with the government to define the research question.

Main product:

- Terms of reference

NDC-LTS alignment tip:

- Clarify possible institutional objectives on NDC-LTS alignment

Step 2: Planning

Step 2 entails crafting a comprehensive work plan that includes scheduling, bibliographic research, selecting modelling tools, and stakeholder engagement to ensure alignment with existing policies and the central science-based policy question. This phase emphasizes collaboration and adaptability, drawing on the Costa Rica case where the Directorate of Climate Change, with support from the Interamerican Development Bank, led an analysis of the National Decarbonization Plan's costs and benefits under uncertainty. This step forms the foundation for effective long-term strategic planning, providing a structured yet illustrative roadmap to navigate the complexities of designing and implementing an LTS.

Activity 2.1: Produce the work plan

After forming the implementer's team, a detailed work plan outlining roles, responsibilities, and alignment with existing policies is essential. Compiling key policy documents, data, and models facilitates informed decision-making. Continuous dialogue with government partners ensures mutual understanding and collaboration, enhancing the project's relevance and impact. Given that funders are often also development partners, it is important to capture the technical insights they bring from similar experiences in other countries.

Activity 2.2: Produce a schedule of activities

Craft a realistic activity schedule for RDM projects, incorporating feedback from the government and funder stakeholders in economic, environmental, and financial planning. The schedule must adapt to the availability of these partners, who are often busy with ministry duties. Typically, RDM projects involve three workshops, meetings, discussions, and analysis, usually within a year, though timelines may vary in changing national contexts. Here is an illustrative work plan.

Activity 2.3: Perform bibliographic research and evaluate tools

Implementers must conduct a thorough bibliographic search to compile crucial documents, data, and models, reviewing national development strategies, energy and sectoral plans, laws, and academic research. This includes gathering data from GHG inventories, demographic and economic projections, energy statistics, land use, and geospatial information, ensuring compatibility with other policy objectives and modelling tools. Selecting the most appropriate tool for the project's goals is vital for effective integration and modelling.

Activity 2.4: Choose the right modelling tool

Implementers must choose between developing new models or utilizing existing tools, considering budget constraints, local model availability, data access, team skills, and government approval. A comprehensive evaluation of technical abilities, data readiness, and model capabilities is essential to selecting the tool that aligns with the project's objectives, ensuring adaptability to unforeseen policy inquiries.

RDM allows the use of existing models in countries, such as those that might be used in ministries of Energy (e.g., LEAP), Ministries of Economy or Planning or local universities.

Activity 2.5: Approve the work plan

Produce and share the updated work plan with the government counterparts and funders, incorporating insights and data from previous activities. This work plan must be approved by all parties, and it must be used to guide the process through.

Key tasks by role:

Government	• Provide the implementer with relevant policy documents and the location of such files. • Show support with mandates for coordination and execution. This can be done through clear governance during the process, participation during workshops and bilateral meetings, streamlined approvals, engagement with public and private institutions, transparent communication, and effective project monitoring. • Define through a governance memo who is responsible for the approval of products, convening consultations, and project team coordination. This is critical for an agile project execution. • Review and approve the work plan and the schedule of activities.
Funder	• Hold meetings with the implementer and the government to discuss in detail the analytical exercise with the existing policy effort. • Review and approve the work plan and the schedule of activities.

Implementer	• Create a work plan that considers how each step of RDM methodology supports the existing policy effort. • Document data of models available to be potentially used in the analytical exercise. • Have clarity of model information requirements. • Analyse existing governmental policies and how the project fits into these policies. • Pick up experiences from similar projects elsewhere.

Main product:

- Workplan

NDC-LTS alignment tip:

Consider aligning timelines and activities of LTS and NDC formulation processes whenever possible. The work plan is a good moment to assess windows of opportunity to enable synergies on issues, such as:

- **Data collection:** Can the data used for the latest NDC be shared?
- **Model selection**: Which model was used for the NDC? Are the assumptions available?
- **Design of workshops:** Is it possible to align the NDC and LTS consultation with stakeholders to avoid stakeholder fatigue? Could we ensure good timing between consultations to address this?

Step 3: First workshop – problem framing

The first workshop is crucial for developing an initial XLRM framework. XLRM stands for Exogenous Uncertainties (X), Policy Levers (L), Relationships (R), and Measures (M) and it is a tool to understand the national context and frame relevant decision problems. The workshop typically opens by discussing the sector with the largest GHG contribution (in many cases, the energy sector, including transport), followed by the second largest [(agriculture, forestry, and other land use (AFOLU)], with the final day covering the remaining sectors (waste and industrial processes). Sessions may be combined or separated based on participant numbers and by considering how public agencies or ministries are organized in a given country. Each workshop session is structured into two distinct phases to ensure a comprehensive and engaging experience:

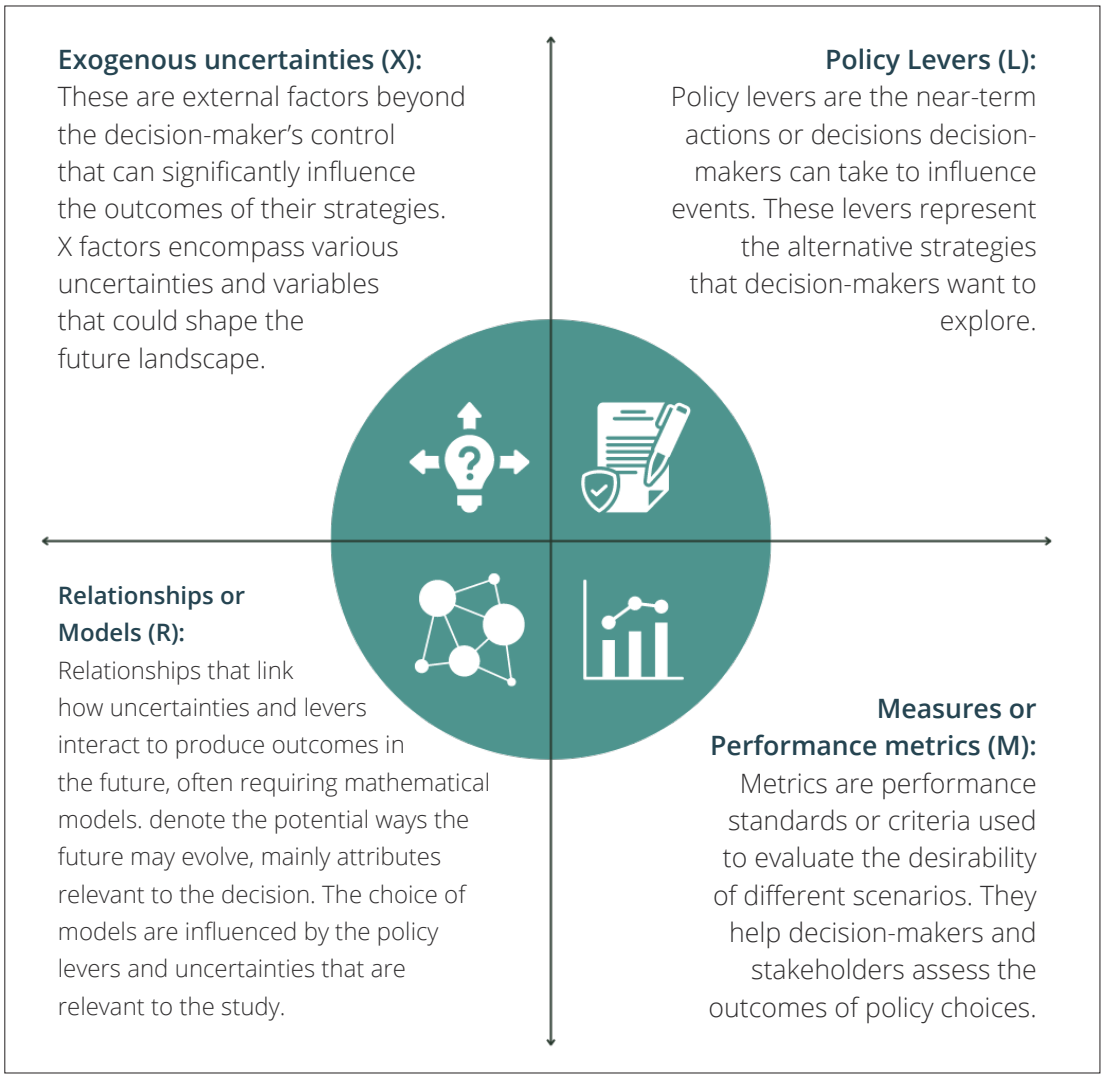
i) Plenary session: Present an overview of the project's background and general context, setting a solid foundation for informed dialogue and engagement. This plenary should include the study's context, specific objectives, overarching methodology, and the projected timeline.

ii) Working groups: Following the plenary, the workshop transitions into interactive sessions organized into working tables. Each day, tables are arranged to accommodate 6 to 8 participants. The objective of the working tables is to co-create the XLRM matrix. Questions can guide the discussion; examples of these questions are presented in Activity 3.5.

Activity 3.1: Embrace the XLRM matrix approach

The XLRM matrix within RDM framework is a tool for systematically examining how different policy levers interact with external uncertainties and relationships to produce future scenarios, all of which can be assessed using specific performance metrics. This approach helps decision-makers identify robust strategies across various possible futures, bringing together multiple world views and evaluating outcomes in the face of deep uncertainty. Below is a short description of each component. Diagram 1 shows the structure of the XLRM matrix.

Diagram 1: XLRM matrix



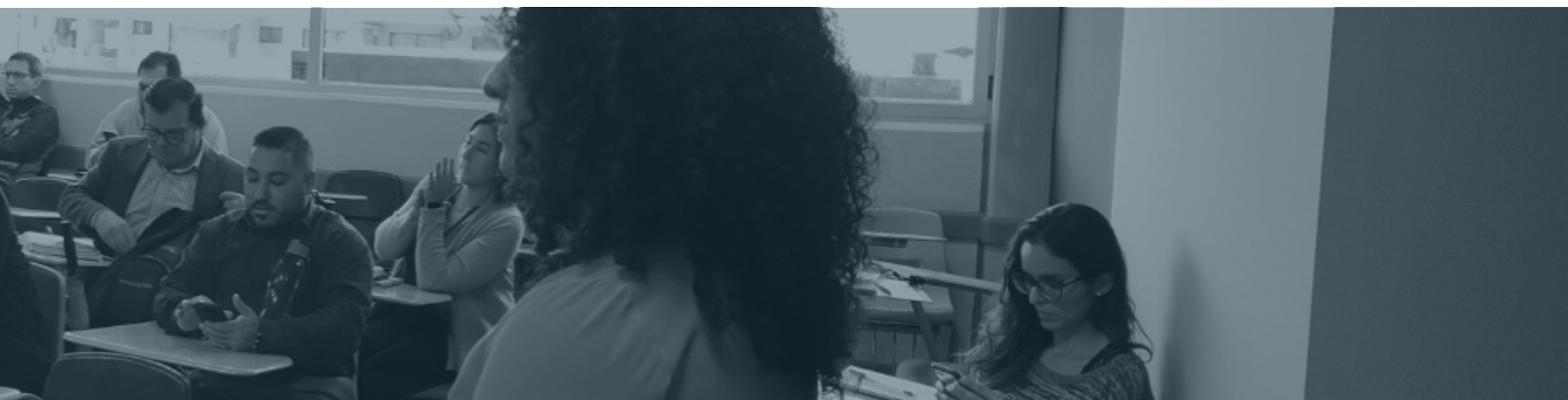
For example, Table 1 outlines the XLRM matrix associated with the decarbonization of the electric sector in the context of the Dominican Republic. Table 2 outlines the XLRM matrix with elements for decarbonization of Ecuador's economy. These were the results from the first round of workshops with stakeholders in both countries and are a good example of issues commonly raised through XLRMs, including country-specific matters.

Table 1: Synthesis of the XLRM matrix from the first co-construction workshop of the decarbonization process of the electric sector in the Dominican Republic.

Exogenous uncertainties (X)	Policy levers (L)
• Cost of fuels • Technological development and its impact on the cost of technologies • Capacity factors (including variation due to atmospheric phenomena)	• Percentage of generation with renewable energy and other sources • Location of projects according to renewable potential, considering the suitability of the transmission and distribution network • Reutilization of plant assets • Energy storage capacity • Replacement of Megawatts (MW) plants and years of replacement • Hibernation scenarios • Implementation of smart grids • Efficiency and energy losses
Relationships or models (R)	**Measures or metrics (M)**
• Recovery data of the current plants' investments • Renewable power maps to determine the regions for resource exploitation and their interconnection with the transmission network	• CO2 emissions • Subsidy on the tariff to the consumer • Costs (financial viability of replacement projects) • Recovery of the investment in thermal power plants • Impact on health • Jobs lost and created • Stability, flexibility, and firmness of the electrical system

Table 2: Synthesis of the XLRM matrix from the first co-construction workshop of the decarbonization process of the electric sector in Ecuador.

Exogenous uncertainties (X)	Policy levers (L)
• Adding petroleum resources to reserves • Price of oil and other commodities • Economic and population growth • Capital cost of new technologies: Hydrogen (H2), Electric Vehicles (EV), Carbon Capture and Storage (CCS) • Availability of areas for reforestation • Reforestation costs • Changes in land use • Per capita waste generation	• NDCs and NAMAs • Electricity master plan • National energy efficiency plan • Sustainable agricultural production • Climate-smart livestock farming • Ecuador zero carbon program: sustainability • Zero fossil fuels in Galapagos
Relationships or models (R)	**Measures or metrics (M)**
• National GHG Inventory • National energy balance • Survey of surface area and continuous agricultural production • Transport statistical yearbook • Solid waste management and inclusive circular economy • ECB imports and exports	• CO2 and GHG emissions • Costs and benefits • Use of renewable energy in the energy matrix • Composition of the vehicle fleet • Forest areas (conserved and reforested) • Sectoral energy intensity • Fraction of treated waste



Activity 3.2: **Promote government ownership**

Ahead of the workshop, it is essential to host a preparation meeting with the government counterparts. ensuring everyone involved in the project comprehends the methodology and their role before the workshop. It is preferable that the government (as high as possible) host the workshop by convening it with stakeholders (e.g. sending the invitations) and actively participating in the event, including delivering the opening for the workshops.

In the Dominican Republic, the participation of the Minister of Energy and Mines and the Executive Vice President of the National Council for Climate Change and Clean Development Mechanism enhanced the credibility of the process and paved the way for a very participatory workshop.

Activity 3.3: **Identify key stakeholders**

Identify key stakeholders, as they will significantly influence the project and participate in workshops and meetings. Stakeholders should represent national sectors relevant to climate change and mitigation policies. Diversity of stakeholders is key to enriching the process and bringing valuable inputs into the XLRM co-design, which can include national and subnational government bodies, multilateral organizations, academia, businesses, NGOs, and community groups. Transparent communication and collaboration with these groups are vital for success of this process. It is advised to produce an initial document that lists stakeholders invited to the workshop.

Activity 3.4: **Plan the workshop**

Choose a venue suited to the number of attendees, prioritizing in-person meetings for better engagement but adhering to protocols for high-profile participants. Opt for cluster seating for a more interactive setup. For online workshops, ensure reliable internet and quality audiovisual equipment. Prepare an agenda outlining activities, breaks, and discussion times to maintain workshop structure. A tentative agenda is:

- [ ] **Participant registration:** At the event's entrance, it is prudent to set up registration stations where attendees can provide essential information, such as their place of employment, job title, email address, work phone number, gender identity, ethnic background, and age group. We recommend distributing the participants from the same entity in different working tables.
- [ ] **Protocol opening:** Allocate a segment in the schedule for high-ranking officials from pertinent ministries to speak, offering them an opportunity to steer the project's direction.
- [ ] **Presentation of workshop and study objectives:** Articulate the workshop's aims clearly, detailing how participant contributions will shape the study. This includes outlining the study's context, specific objectives, overarching methodology, and the projected timeline.
- [ ] **Space for dialogue:** Designate a segment for attendees to raise inquiries and discuss the study's methodology.
- [ ] **Interlude**
- [ ] **Break**
- [ ] **Explanation of the dynamics:** Provide a comprehensive explanation of the procedures for group activities at the designated worktables.
- [ ] **Collaborative table sessions:** Establish worktables, each facilitated by a moderator. These moderators will drive the conversation by posing guiding questions. Attendees are encouraged to document their insights, which will be displayed on a common board (flip charts are also helpful) for collective review at the end of the workshop.
- [ ] **Conclusion and collective insight sharing:** Each group will present the core takeaways and suggestions for incorporating into the Strategy's framework. Designate a spokesperson for each group to relay the collated insights to the broader assembly.
- [ ] **Closure and next steps:** Close the workshop and explain the next steps related to the project execution.

Drawing on previous instances, the workshops are scheduled to commence at 8:30 a.m. and conclude at 12:45 p.m. Please note the allocated registration period of at least 30 min. In Guatemala, a minute-by-minute agenda was developed. The flow of the workshop must be flexible to allow sufficient time for participants to react to the material presented.

Activity 3.5: Create engaging workshop materials

Present workshop materials engagingly, with questions that guide the discussion and keep participants involved and enthusiastic.

Before the workshop, prepare a pre-workshop concept note explaining what to expect from the workshop and highlighting Why, What, and How. Including examples demonstrating how RDM provides unique insights beyond standard scenario analysis would be ideal. Engaging in discussions and making necessary adjustments with the funder and government counterparts are important.

Develop tailored questions and activities based on the profiles of participants and the specific research objectives. These should be thoughtfully tailored to suit the unique profiles of the participants and align with the specific objectives of the research.

Examples of such questions by sector include:

Energy:

- By what percentage should the use of private cars using fossil fuels be reduced?
- What project options are envisioned to replace coal plants?
- Is there a legal analysis of the coal plants closures?
- What types of fuels could partially replace fossil fuels in land transport by 2030 and 2050?

Agriculture, Forestry, and Other Land Use:

- What databases concerning forests, land use (crops), cattle farming, and GHG emissions are available in the country?
- What risks or difficulties do you foresee in implementing measures to improve the bovine diet to reduce enteric fermentation?
- What risks or difficulties do you foresee in implementing measures to reduce deforestation and increase forest cover in the country?

Waste:

- What policies could be implemented to increase the percentage of household recycling and composting?
- Do you consider it possible for the government to facilitate measures and build infrastructure to increase the number of wastewater treatment plants and for households to join the municipal sewerage system?

Industrial Processes:

- Is there information about the future evolution of the cement market in the country (domestic production and demand, clinker/cement imports, clinker/cement exports)?

- What is the minimum technically feasible future clinker factor in the average composition of the total cement produced domestically? What material or materials will replace clinker in the cement mix according to availability in the country?
- From your experience in recent years, do you believe that customers are open to purchasing products with a lower clinker factor?
- What other proposals have been identified to reduce GHG emissions from non-cement industrial processes and use GHG-emitting products?

Crosscutting questions:

- What will success look like in 2050 for each specific sector?
- What are the key indicators you need to measure success?
- How are the Ministry of Finance and the planning ministry or commission involved?
- How do you measure the macro-economic impact of the different proposed measures?

What should the presentation include?

- International context about climate change and LTS development
- Local context about socioeconomic variables, emissions, and the impact of climate change in the country
- International experiences about the usage of RDM, highlighting results from each case study
- Explanation of the methodology
- Explanation of the co-creation activity
- Wrap-up and next steps regarding the execution of the LTS

On the day of the workshop, prepare the room with an atrium layout and a central table for effective participatory workshops for facilitators. Equip the space with necessary audio-visual gear, including a quality sound system, a projector, and two microphones (preferably wireless for ease of movement), and ensure on-site technical support. Make sure there is reliable internet access in the venue.

Each table should have whiteboards or flip charts for notetaking and idea-sharing. Having post its or paper cards, pilots, sheets of paper, and pencils on each table is recommended. Additionally, each table can have a preliminary XLRM Matrix to facilitate a structured and productive dialogue. This initial framework invites stakeholders to contribute their insights, refine the content, and align it more closely with their experiences and expertise.

Activity 3.6: Train and prepare moderators

Moderators at each table are keys to a successful workshop. Their role is to keep discussions on track, ensure everyone participates fairly, and manage time effectively to keep the session productive. Suppose there is not enough people. In that case, champions can be appointed at each working table to guide the conversation.

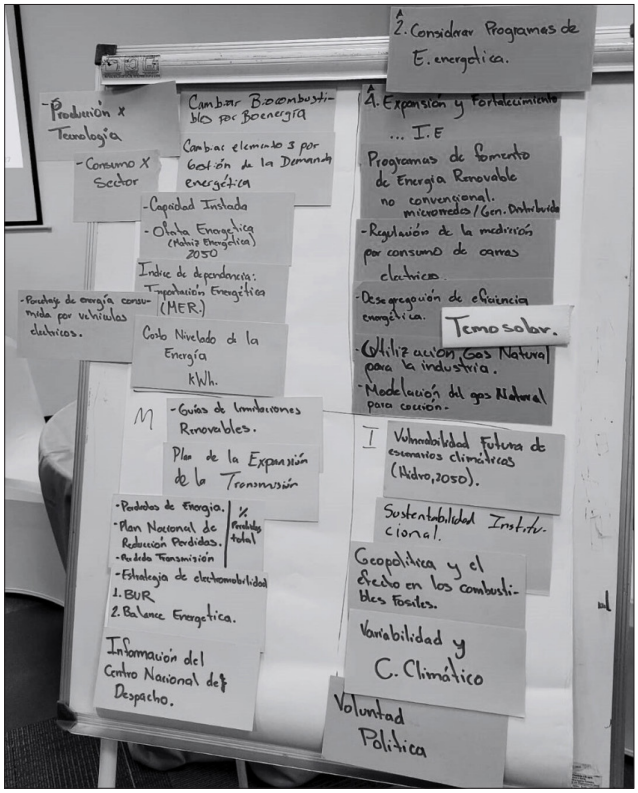
Tips for moderators:

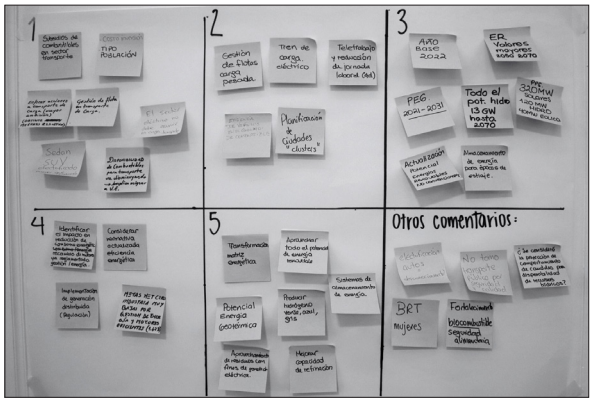
- **Create a welcoming environment:** Foster a safe and inclusive atmosphere where all participants feel comfortable sharing their ideas and perspectives.
- **Stay neutral:** Maintain impartiality and avoid expressing personal opinions or biases. Your role is to guide the discussion, not influence outcomes.
- **Time management:** Keep the workshop on schedule by managing time effectively. Allocate specific time slots for each agenda item and stick to them.
- **Active listening:** Pay close attention to what participants say. Encourage active listening by summarizing key points and asking clarifying questions.

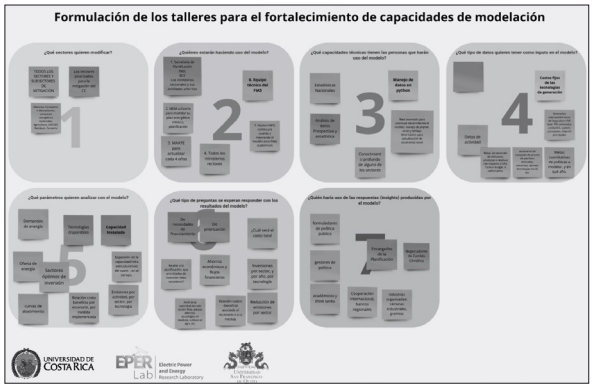
Activity 3.7: Develop the workshop

Arrive at the venue at least one hour early to ensure everything is set up correctly. Adhere to the agenda during the workshop, but prioritize responding to the audience's questions and feedback, making agenda adjustments if necessary.

Diagram 2: Examples of insight gathering







Engage participants in the working tables, drawing on the moderator tips from Activity 3.6. Ensure all tables have the necessary materials, as listed in Activity 3.5. Use guiding questions to stimulate discussion and have participants note their thoughts, context, and perspectives on post its. Refer to examples of insights in Diagram 2. Consider using tools like Miro, Kahoot, Microsoft Whiteboard, or Jamboard for virtual workshops to collect participants' input.

As the project progresses, the implementers must weave the XLRM matrix into the models. In Activity 4.1, we describe principles to incorporate the inputs in the analytical exercise.

Activity 3.8: Workshop wrap-up

Create a post-workshop concept note summarizing the workshop's methodology, participants, outcomes from the XLRM matrix, key insights, agreements, and areas marked for further exploration. Digitalizing all the insights and classifying them is recommended. This document serves as a concise reference for all participants. Simultaneously, an internal framework should be established to outline upcoming actions and expected post-workshop progress. Once finalized, share it with the government counterparts and funders for approval and distribute it to the workshop participants. It's good practice to make concept notes and PPTs available to the public – Chile created a public website with information available to the public.

Key tasks by role:

Government	• Draw out an initial list of potential stakeholders for the workshop, both internally within the government and externally. • Assist the implementers with logistical aspects, reviewing the guest list, and sending invitations. • The government should take ownership of the methodology, inviting the audience, and opening the workshops. • Review and give feedback on the products under this step.
Funder	• Closely support the technical team and communicate with the government through this process. • Review and give feedback on the different products.

Implementer

- Create a presentation for stakeholders with concepts, work to be done, and clarification of project scope, etc.
- Confirm which stakeholders will participate.
- Prepare clear presentations and share them with stakeholders (e.g., explain technical jargon, definitions, methodology, context, etc.).
- Prepare a script for moderators with technical questions to keep answers consistent.
- Identify key participants for bilateral meetings based on their contribution to the workshop conversation.
- In the post-workshop report, ensure that actions emerging from the workshop are captured and followed up with relevant stakeholders.
- Determine how to represent XLRM aspects in the quantitative model.

Main product:

- Pre-workshop concept note (agenda, invitee list and logistical plan of the workshop)
- Slide deck for the first workshop
- Co-design XLRM Matrix
- Post-Workshop concept note

NDC-LTS alignment tip:

- Map the ongoing initiatives within government institutions to capture short-term actions that will catalyze long-term goals.
- Share a list of stakeholders from previous NDC formulations to include them in the LTS workshops as well.

Step 4: Scenario creation

Step 4 focuses on creating plausible scenarios to address the concerns of stakeholders. This step involves data collection, model adjustments and calibration, and iterative creation and review of the results with stakeholders. The XLRM matrix is the basis of this step and the implementers must ensure that the concerns and ideas highlighted in the first workshop are addressed.

Activity 4.1: Collect data and model adjustments

When incorporating the inputs into the design of the analytical exercise for an LTS, the implementers should first identify the knowledge gaps and priorities of stakeholders. Understand what policy levers and metrics instruments stakeholders are interested in evaluating—such as private and public investment, mandates, or fiscal changes. It is important to adjust the base model to adequately compare technology and infrastructure options on an emissions and cost-benefit basis. If stakeholders are also interested in the indirect effects of policies, a multi-model approach should be considered. This could involve using complementary models to deepen the understanding of specific policy levers and to explore indirect effects on other sectors of the economy not captured by the base model. In Costa Rica, a General Equilibrium Model was used to complement the Open Source energy MOdelling SYStem (OSeMOSYS) models (G. Godinez et al., 2018; Groves et al., 2020).

Engage the stakeholders to provide the most trusted and latest data available. This data should cover a range of categories, from historical and current data describing the system within the economy to policy data and expert views showing prospective changes. The chosen data should help calibrate the models, capture enacted policies, and inform uncertainties and alternative policy lever possibilities.

In the Dominican Republic, the stakeholders provided access to multiple data repositories, ranging from the country's long-term planning to the operational aspects of the electricity system. This significantly enhanced the analysis.

Flexibility in the model is more valuable than focusing on a high-level of detail at the initial stages. A model that can capture multiple possibilities is preferred, with refinement for detail and granularity considered only if necessary to illuminate specific questions. This approach balances computational time and model complexity, ensuring that the models remain transparent and understandable for both the implementers and stakeholders. In Costa Rica, Peru, Guatemala, Ecuador, and the Dominican Republic open-source tools like OSeMOSYS (Howells et al., 2011) in their Climate, Land, Energy, and Water (CLEW) implementations (Ramos et al., 2020) helped represent economy-wide systems in detail. This facilitated transparency and replicability because of null licensing costs and highly available learning resources.

Costa Rica made its model publicly available (https://github.com/EPERLab/osemosys-cr-v2) and Ecuador has followed its path (https://github.com/PLANMICC/OSeMOSYS-Ecuador). Optimization models are widely used but simulation software is sometimes suggested as they offer speed and flexibility. Some examples available in the literature are the bottom-up LAC model (UNEP, 2022), MAURISE-RD (Quirós-Tortos et al., 2023), and SISEPUEDE (https://sisepuede.readthedocs.io/en/latest/) (Kalra et al., 2023).

Finally, maintain a working database that can accommodate future data updates l for the project's relevance throughout its duration. The results should inform the database of the bibliographic search conducted in earlier steps and insights gathered during the initial workshop. Essential data for a typical base model includes energy balances, emission inventories, technological costs, macroeconomic data, and environmental accounts. This comprehensive approach ensures that the modelling framework is well-prepared to accurately represent activity data and assess the costs and benefits of deploying the LTS or related policies.

Activity 4.2: Calibrate the model

Calibration involves tweaking a model's settings to reflect a country's historical data and current conditions, enhancing its ability to generate realistic, relevant scenarios for decision-making. If an existing model is available, adapting it to the project's needs is more efficient than starting from scratch. The key is to ensure the model includes variables related to the policy levers or strategies identified during the initial workshop, facilitating accurate scenario exploration. Calibration prioritizes national data, but when this is insufficient, international data may supplement the process. Continuously engage with stakeholders and government officials to refine scenarios and align them with updated insights and objectives.

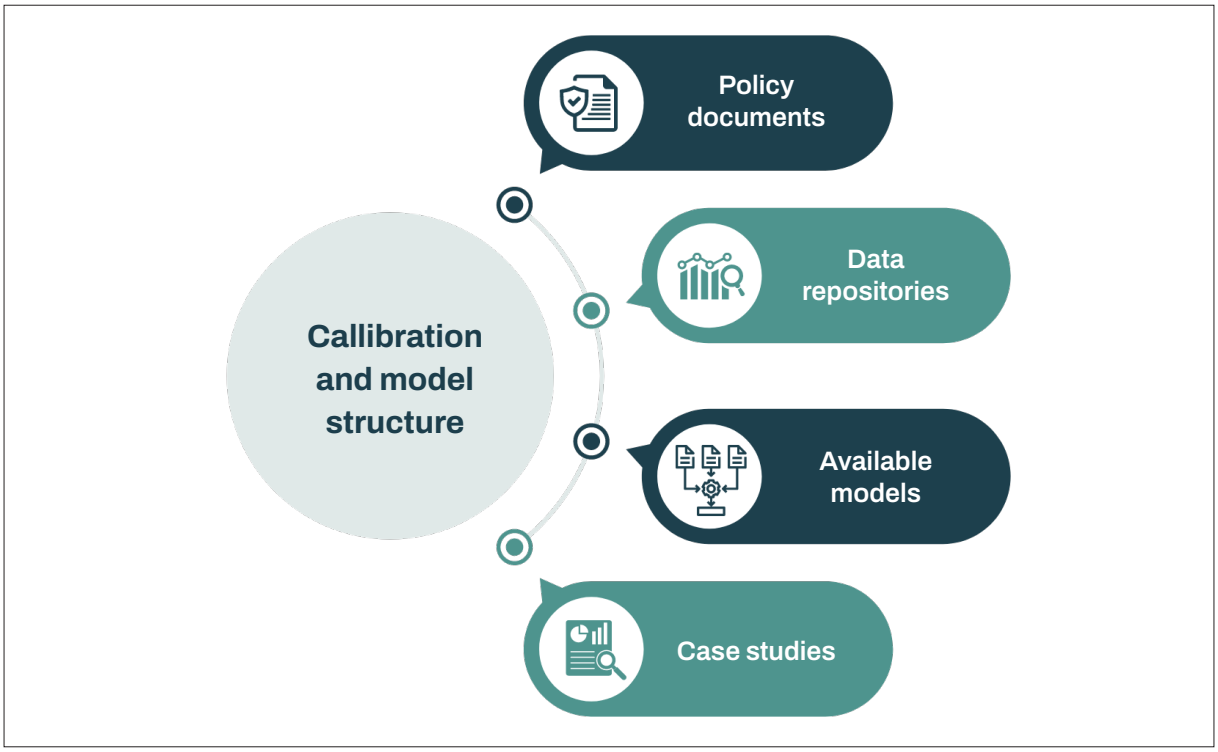
Activity 4.3: Craft base scenarios

Creating a practical model involves integrating elements identified during the XLRM exercise (see Diagram 3) with scenarios depicting potential future states based on coherent storylines and strategies. For instance, the scenarios in the Dominican Republic were tailored to plausible narratives, considering efforts such as the push to increase flexible generation with the incursion of natural gas.

The "Future 0" concept is crucial in RDM as it serves as the baseline from which other futures diverge. Base scenarios offer consistent visions of future system states, constructed in sets to illustrate various possible trajectories without assigning probabilities, aiding long-term climate policy planning. Implementers must carefully balance model development with its utility and credibility, avoiding overemphasising outdated elements and focusing on current sector needs and project scope.

Budget considerations for simulation time and computational resources are critical when developing or adapting models, with more complex models requiring more storage and longer processing times. Practical adjustments may include prioritising computational efficiency over detail, provided this does not compromise the integrity of policy insights. Leveraging national models can expedite implementation, but this requires proper training and access to necessary inputs to generate multiple simulations, ensuring the model's effectiveness in later steps.

Diagram 3: Elements that feed development of calibration and model structure



Activity 4.4: **Presentation of the first set of scenarios**

For an impactful presentation to the funders and government counterparts, integrating well-crafted figures is crucial for clearly and effectively communicating the created scenarios. Visual aids should simplify complex data, making it easier to interpret and compare, thus accentuating major trends, unveiling hidden patterns, and spotlighting pivotal discoveries. The results must answer concerns highlighted by stakeholders and delineated in the metrics part of the XLRM matrix. Utilise data visualisation tools like Tableau, Power BI, or Excel for creating engaging charts and graphs, ensuring each visual is annotated for clarity. Practice explaining the methodology behind each scenario to build credibility. Diagram 4, Diagram 5, and Diagram 6 from studies by (Quirós-Tortós et al., 2021) (Quirós-Tortos et al., 2023) serve as excellent examples of how to convey information effectively. Engage with your audience for feedback, using their insights to refine future presentations and foster collaboration, demonstrating practical ways to enrich and elucidate findings with well-designed visuals.

Activity 4.5: **Review results**

The inputs provided by the funders and the government, along with the team's expertise, will allow for refinement of the results to produce Future 0 with the best assumptions and considerations based on the country's reality. The Future 0 of each scenario will be the basis for executing the following RDM experiment (step 6). Make sure comments are addressed before this experiment. Funders would typically possess technical knowledge from similar exercises in different countries. When engaging with them, make sure to capture their insights to favor the analytical exercise.

Diagram 4: Total GHG emissions in Peru

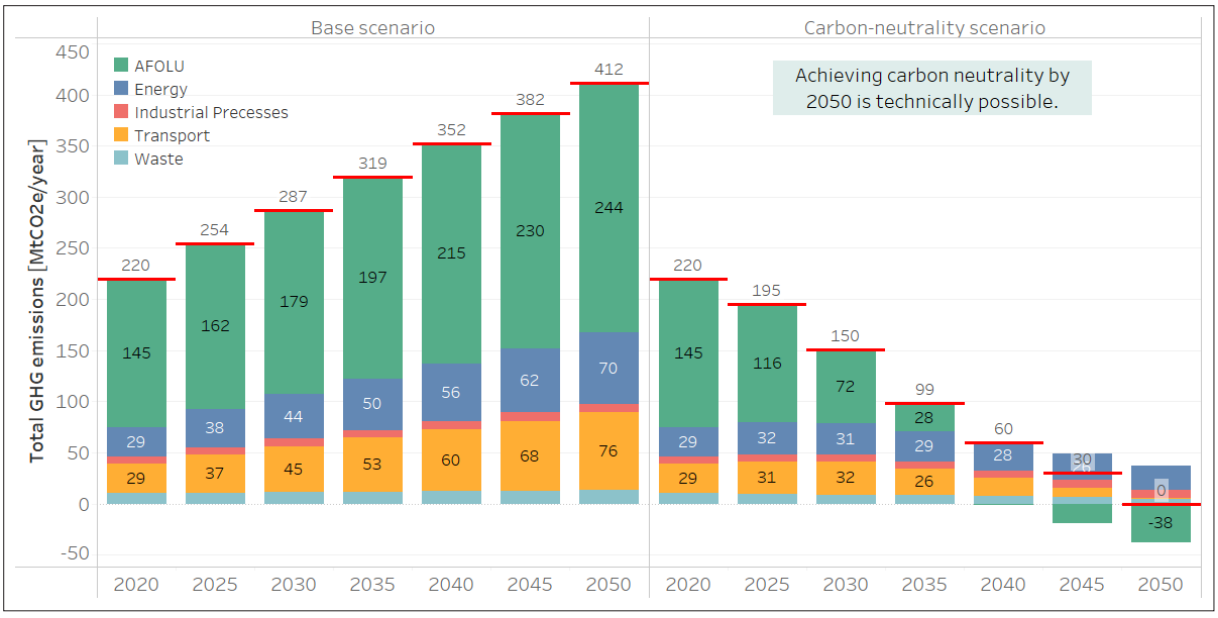


Diagram 5: Electricity Production in the Dominican Republic

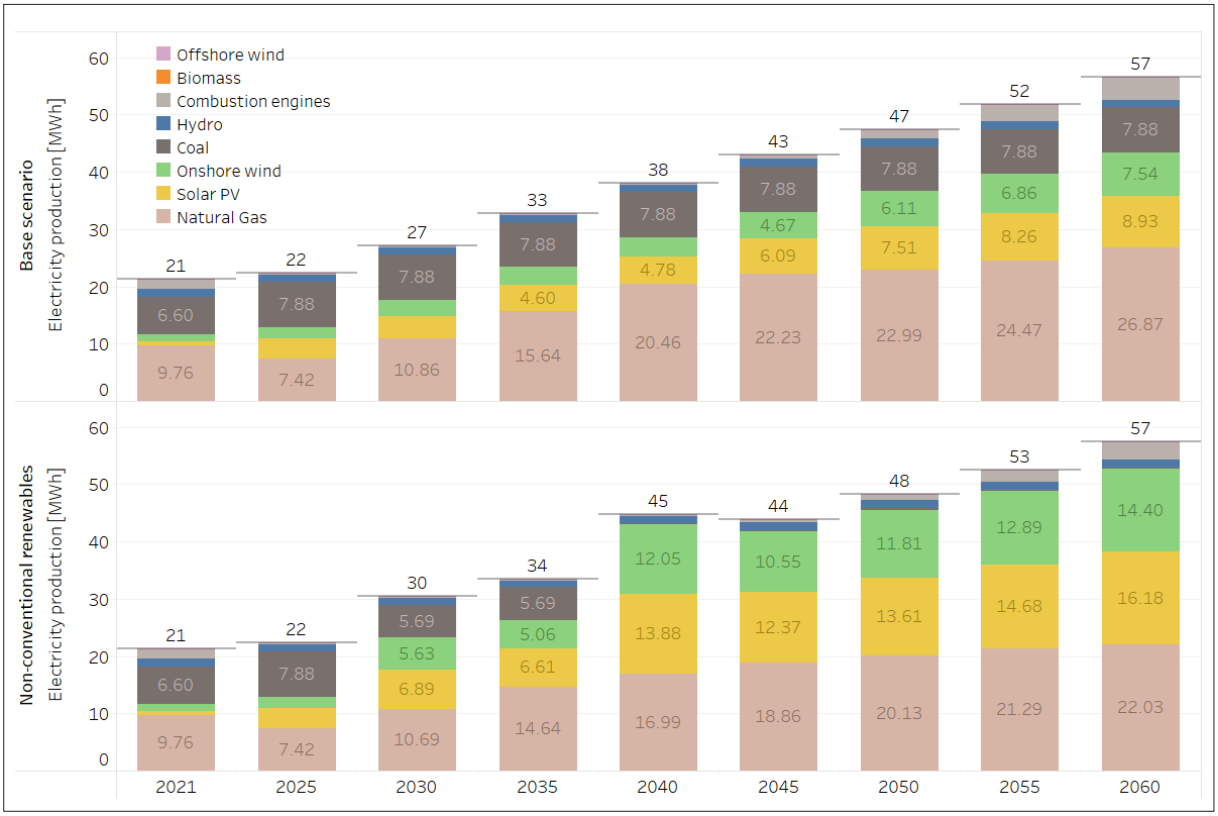
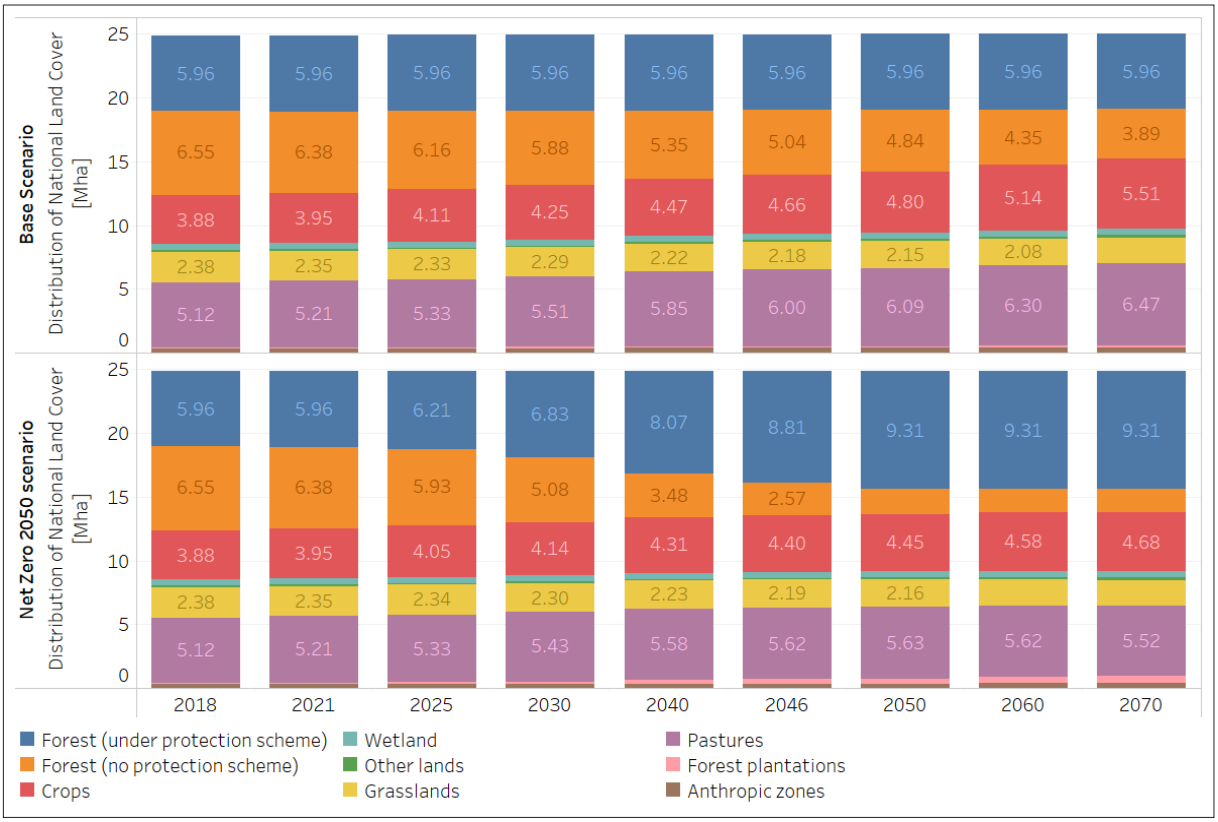


Diagram 6: Distribution of National Land Cover in Ecuador, preliminary results



Key tasks by role:

 **Government**	• Participate in the review of the model, ensuring that it aligns technically with the country's characteristics. • Collaborate closely with the implementers to ensure the variables and scenarios incorporated into the model capture policies defined in the initial workshop. • Assist in providing access to relevant data sources, especially if international data is required to supplement the existing information.
 **Funder**	• Participate in the review and feedback process, providing insights and guidance as needed.
 **Implementer**	• Create the structure of the model. • Calibrate the model. • Incorporate Policy Levers. • Produce the base scenarios. • Document the model's structure, equations, assumptions, and data sources. This documentation is crucial for transparency and reproducibility.

Main product:

- Summary of relevant data highlighting the sources
- Base case scenarios
- Presentation with results

NDC-LTS alignment tip:

- Review previous NDC modelling assumptions and consider options to harmonize those with the LTS modelling process.
- Results should reflect short-term commitments and suggest possible improvements in short-term plans.
- An NDC scenario may be needed along with the net-zero by mid-century scenario for comparison purposes.

Step 5: Stakeholder engagement and bilateral meetings

Activity 5.1: Build an agenda

Implementers and government counterparts should set bilateral meetings to promote collaboration, receive insights, enhance understanding, and empower stakeholders with the methodology. These sessions should embody thoughtful planning and incorporate participatory exercises, laying the groundwork for purposeful discussions and comprehensive engagement.

Bilateral meetings may be in-person or virtual. In-person meetings are suggested when highly participatory activities are needed; otherwise, virtual meetings can be held.

Activity 5.2: Tailor questions for bilateral meetings

Implementers should include specific questions or information requirements in preparation for the bilateral meetings. Furthermore, clarity on confidentiality issues surrounding sensitive information is necessary. Efforts are directed towards collecting additional essential information or deepening existing datasets. These meetings also serve as an intermediate validation process, ensuring that the data used aligns with the evolving project requirements. For instance, in the Dominican Republic, the results were first presented and discussed with the private generators who own coal plants, offering unique perspectives of stakeholders affected by the decarbonization policies.

Activity 5.3: Prepare material for bilateral meetings

Effective communication with counterparts clarifies which elements of the XLRM matrix are feasible for simulation. Some uncertainties may be out of scope or too complex to simulate, and this distinction should be transparent. A slide deck with a summary of the project and preliminary results would help engage the stakeholders. Ensure the questions that need to be answered are included in the slide deck for discussion during the meetings.

Activity 5.4: Execute bilateral meetings

Sharing scenario results with stakeholders is recommended to enhance transparency and promote widespread understanding. Effective communication of results should ensure that insights are appropriately disseminated and comprehended, with subsequent feedback collection for analysis refinement via suitable communication channels (in person or digital).

Activity 5.5: Follow up on bilateral meeting to maintain engagement

Continue to interact with key authorities and policymakers. Their ongoing involvement helps maintain alignment with overarching objectives and policy considerations.

Activity 5.6: Keep track of the meeting agreements

Consistent and thorough documentation remains essential. Detailed reports capture discussions and formalise agreements made during the stakeholder meetings.

Key tasks by role:

Government	• Accompany the implementers in the bilateral meetings. • Embrace the methodology and be capable of transferring the results and questions. • Collaborate with the implementers in data collection and validation efforts. Ensure that the data used in these meetings align with evolving project requirements and remain accurate and relevant. • Collaborate with the implementers to tailor specific questions or information requirements for the bilateral meetings. Address any issues related to confidentiality, especially concerning sensitive information.
Funder	• Engage with authorities and policymakers throughout the entire process. • Participate in the review of meeting agendas and provide feedback to ensure alignment with project objectives.
Implementer	• Plan and organise participatory exercises that enhance stakeholder engagement and provide a platform for in-depth discussions. • Transparently explain the methodology. • Include specific questions or information required from stakeholders in the bilateral meeting and clarify confidentiality issues. • Arrange and facilitate virtual or in-person meetings as needed, tailoring the format to specific contexts. Ensure that the necessary technology and logistics are in place for seamless communication. • Document the actions emerging from the bilateral meetings and follow up with counterparts to ensure accountability. • Collect the necessary information or deepen the existing one.

Main product:

- Slide deck for the bilateral meetings
- Document with key questions, data, and insights from bilateral meetings

NDC-LTS alignment tip:

- Consider planning the engagement activities with the NDC updating timeline in mind, seeking to integrate the consultation processes.

Step 6: Exploratory modelling and scenario discovery

Exploratory modelling and scenario discovery – two key components of RDM methodology – involve defining uncertainties and creating key visualisations to engage in a dialogue with stakeholders to create robust scenarios.

Activity 6.1: Specify uncertainties

Implementers should organise uncertainties from the workshops and meetings, choosing variations based on literature and expert input to enhance discussions. Key principles for incorporating the inputs highlighted in the XLRM matrix into exploratory modelling include keeping base year values constant, adjusting final values and interpolating between, adding non-linear behaviours for technology diffusion, understanding the impact of non-time series parameter variations, and defining variations as relative changes with a range from -50% to +50% to reflect different assumptions. Variation ranges should align with stakeholder concerns, allowing for the simulations to explore various technology adoption rates.

Activity 6.2: Generate a multiplicity of simulations capturing uncertainty

This activity involves generating numerous simulations to cover a wide range of uncertainties, effectively linking various assumptions to their outcomes without bias. The advantages of creating multiple simulations include stress-testing the base scenario (Future 0), answering diverse "what-if" questions, and identifying conditions under which strategies might succeed or fail. To produce these simulations, sampling methods like Latin Hypercube Sampling are used to comprehensively map the input space, ensuring a high-level of representation. This approach allows for the exploration of different combinations of inputs (Xs and Ls in the XLRM matrix) across scenarios, creating additional "Futures" for analysis. The experiment is executed by iteratively running the models with parameter variations according to the samples generated.

Activity 6.3: Explore outcomes and vulnerabilities: A two-pronged approach

The next activity is designed to explore the policy outcomes and vulnerabilities, offering options for varying degrees of complexity.

- *Visualizations: An initial overview*

As an introductory tool, visualisations can reveal a cursory look at key trends, patterns, and potential vulnerabilities or opportunities within the policy landscape. These visualisations can be mapped onto a narrative that explains why a strategy succeeds or fails, i.e., explaining vulnerabilities.

- *Scenario discovery: A systematic exploration*

Scenario discovery is an advanced tool for extracting insights from multiple situations, pinpointing key drivers of policy outcomes. Analysts must present findings in a way that stakeholders can easily grasp. Techniques like the Patient Rule Induction Method (PRIM) isolate parts of the parameter space linked to specific outcomes, while Classification and Regression Tree (CART) analysis divides the input space into segments based on binary splits, visually represented through a decision tree, highlighting distinct scenarios. Breakpoint analysis, another method (see https://uncertainfutures.github.io/) identifies critical parameter values at which strategies might fail. These explorations, ideally followed by initial visualisations and stakeholder discussions, enhance the depth of analysis and ensure the clarity of results.

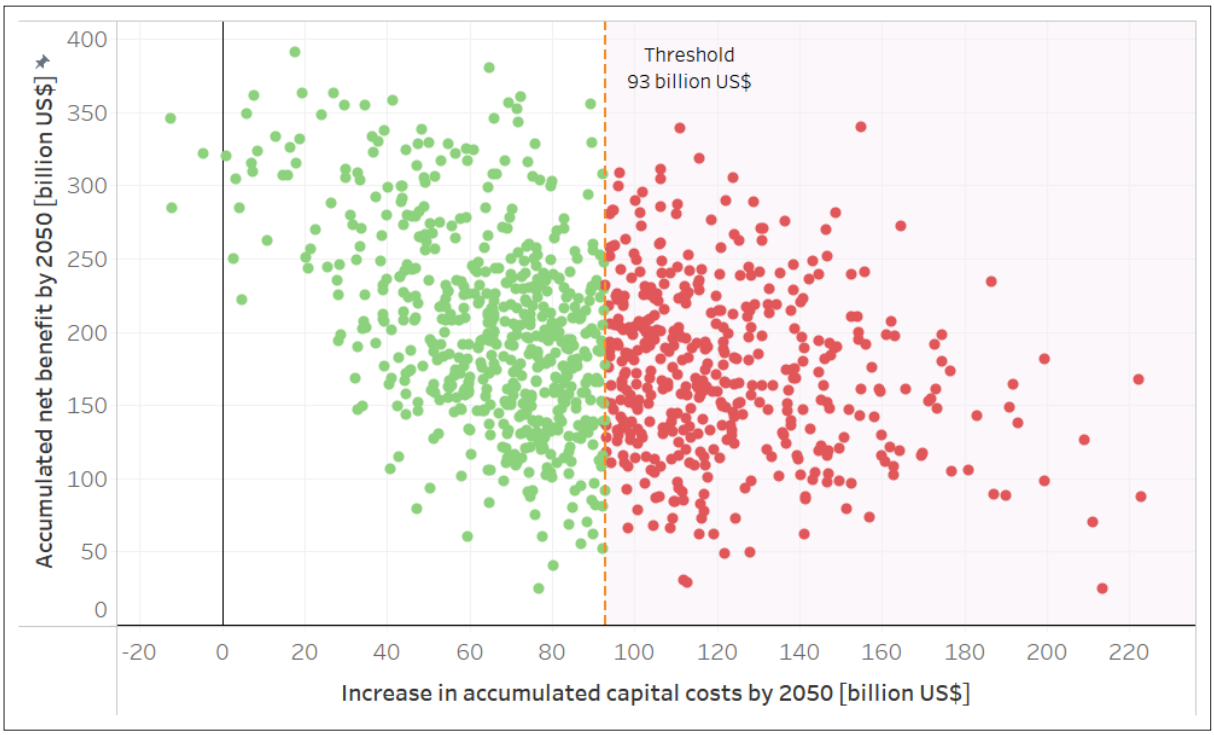
Activity 6.4: Extract actionable insights

Document insights from visualisations and scenario discovery in a narrative format. This enables comprehensive and nuanced analysis, aiding stakeholders to effectively interpret the results. PRIM should enable the implementers to find policy conditions where the selected input space covers the criteria of interest (high coverage score), avoids irrelevant outcomes (high-density score), and is easy to understand (a narrative can be developed with the results and participating stakeholders can comprehend it). This activity involves stating the ranges at which the strategy has good performance. Therefore, the stakeholders can choose to incorporate any quantitative goals linked to simulations with positive metrics into the LTS.

Activity 6.5: Present the first set of simulations

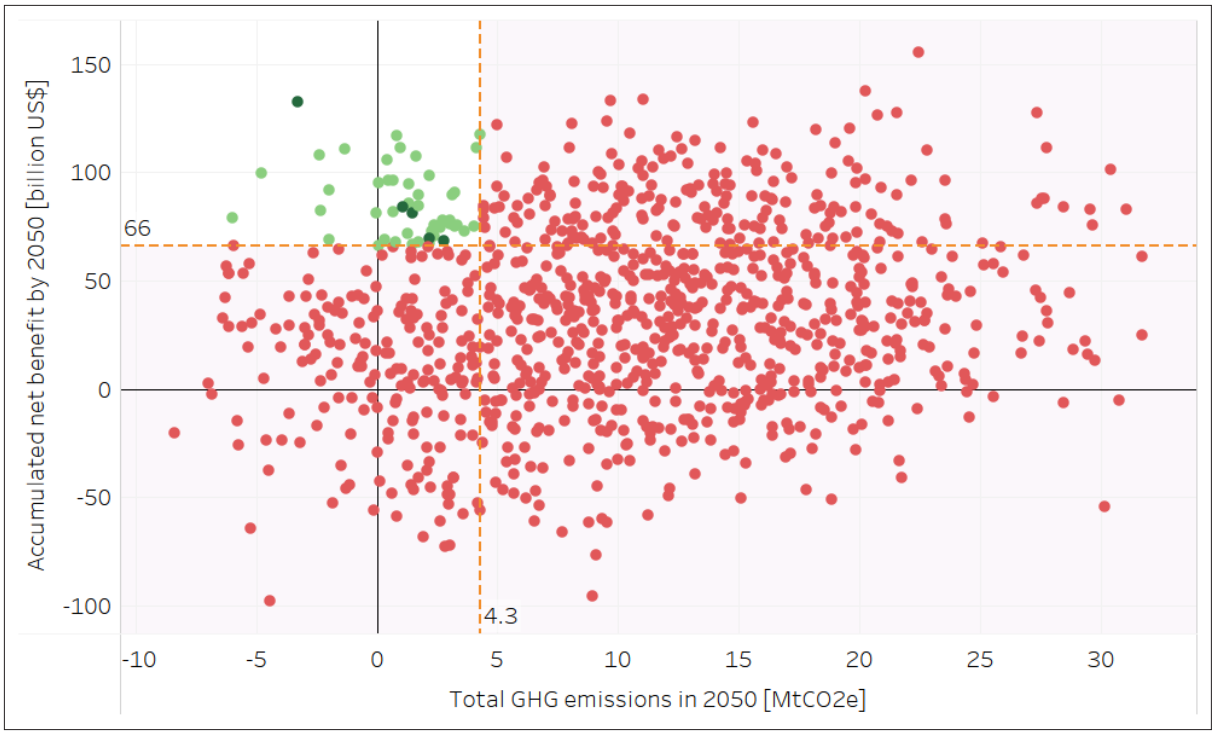
This activity aims to present to the funder and government counterpart to receive feedback on the simulations that explore uncertainty. It involves showcasing visual aids that bolster the scenario analysis. For instance, Diagram 7 illustrates the findings from the analysis conducted in Peru, highlighting the correlation between accumulated net benefits by 2050 and the increase in capital costs. In Ecuador, in Diagram 8, the focus was on scenarios combining lower emissions with higher benefits. This approach also facilitates sector-specific analyses, as demonstrated in Costa Rica's case, where emissions and benefits within the transport sector were examined (Diagram 9).

Diagram 7: Example of visualization in the Case Study developed in Peru (Quirós-Tortós et al., 2021)



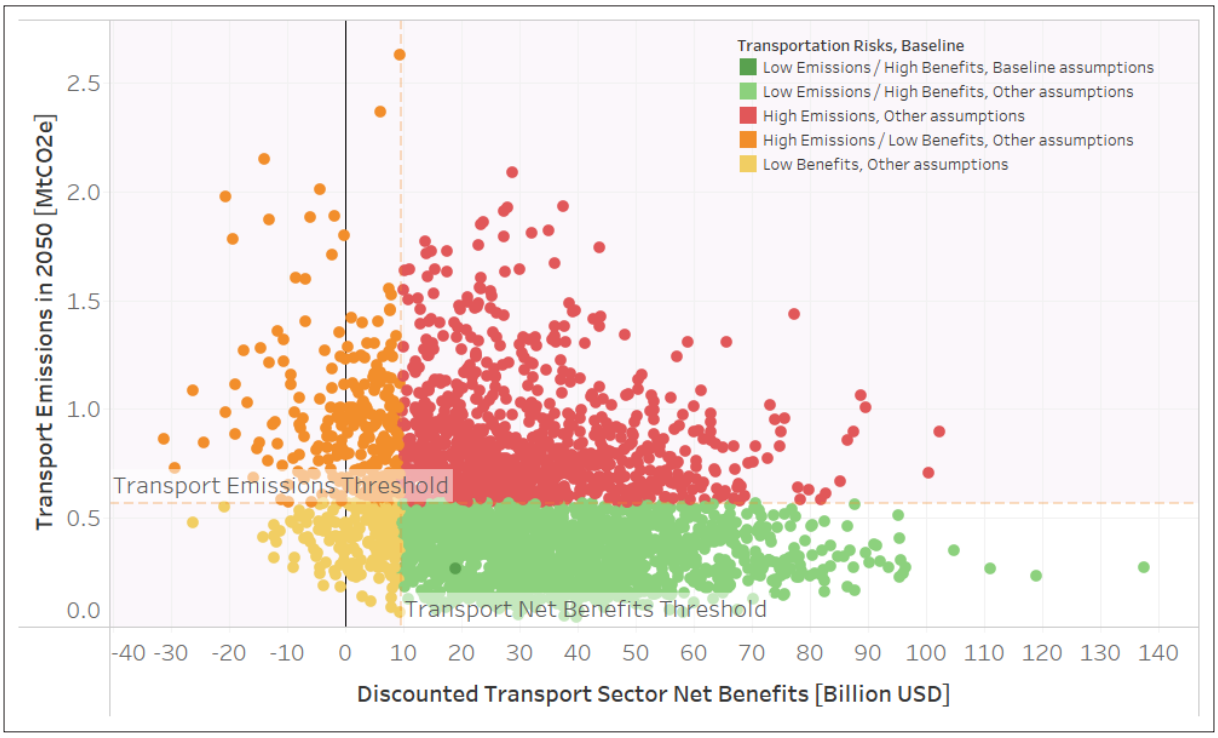
Note: Achieving carbon neutrality in Peru will require additional investments in practically 100% of the routes explored. 43% of these routes (marked with red circles) require investment exceeding those of Future 0 (US$93,000 million).

Diagram 8: Example of visualization in the Case Study developed in Ecuador (under development, pre-release GitHub)



Note: Ecuador explored four aspects in these visualizations. Total annual emissions (in MtCO2 equivalent) for 2070 against the net financial benefit (excluding externalities) for 2023-2070, with values discounted to 2023's present value using a 5.5% discount rate. Dotted orange lines demarcate emission levels at 4.3 MtCO2e and benefits of 66 billion USD in 2023, defined as thresholds by stakeholders. Above these lines, 48 light green points represent scenarios with low emissions and high benefits, with the top 5 most plausible futures highlighted in dark green.

Diagram 9: Example of visualization in the Case Study developed in Costa Rica (Groves et al., 2020)



Note: The figure shows emissions from the transport sector in 2050 versus discounted net benefits for 3,003 futures, and it indicates which results would not achieve the National Decarbonization Plan goals. Dots coloured red and orange are high GHG emission cases. Symbols coloured yellow and red are low-net benefits cases. Symbols coloured green are those cases that are both below the emissions threshold and above the net benefits threshold.

Activity 6.6: Review results

The implementer will assess the results of this activity, ensuring necessary model adjustments are made. The aim is to create a cohesive simulation set that effectively accounts for uncertainties. Based on the previous insights, the implementer will have to fine-tune the experiment and prepare comprehensive materials for presentation to both the government counterparts and funders. Leveraging prior findings and achievements, develop informative materials showcasing the progress and outcomes.

Informing an LTS through RDM is notably tool-intensive, relying on various instruments to manage multiple models and variables. One critical aspect to consider is the computational burden these tools can impose. Several accessible options designed to handle and implement the computational aspects of RDM are available. The following tools exist to support the deployment of RDM exercises (see https://uncertainfutures.github.io/ for more details):

- **Sdtoolkit:** A package for the R statistical programming language to perform scenario discovery using the PRIM algorithm.
- **Exploratory Modelling and Analysis Workbench (EMA Workbench):** A Python package to set up, perform, and analyse models as part of exploratory modelling.
- **Orange:** A C++ library with Python bindings for many valuable data mining and machine learning algorithms, including CART.

If the implementers choose OSeMOSYS (see Step 4), its standalone version only allows modelling sectors and their technological pathways. However, its flexibility in running with Python allows easy integration with existing libraries to execute exploratory modelling and scenario discovery. Tools like the pyDOE package generate the different parameters for multiple futures through an experimental design (https://pythonhosted.org/pyDOE/). Multiprocessing (https://docs.python.org/3/library/multiprocessing.html) allows modellers to deploy multiple runs (Victor-Gallardo et al., 2023). The PRIM for scenario discovery algorithm can be executed with a standalone module (https://github.com/Project-Platypus/PRIM) from the EMA Workbench (https://github.com/quaquel/EMAworkbench). Other available tools and studies in the literature with a comprehensive scope to inform an LTS design include:

- This guidebook recommends using scenario planning, Adaptive Pathways, and RDM to bolster transportation resilience against climate change in Latin America and the Caribbean, highlighting the suitability of Decision Making Under Deep Uncertainty (DMDU) approaches for projects facing numerous decisions and climate vulnerabilities (Lempert et al., 2021).
- This paper presents the Multi-Objective Robust Decision Making (MORDM) framework, combining evolutionary optimisation, RDM, and visual analytics for environmental management. MORDM evaluates solution robustness under uncertainty and identifies critical influences on effectiveness (Kasprzyk et al., 2013). The OpenMORDM R library supports this with model integration, uncertainty management, robust design identification, and interactive visuals (https://www.scrim.psu.edu/resources/openmordm/).
- This study optimises emissions-reduction strategies under uncertainty, emphasising robust solutions to align with the Paris Agreement targets (Ferrari et al., 2022). It identifies four robust pathways considering climate, social, and economic trade-offs, highlighting equitable benefits for developing regions most affected by climate change.

Key tasks by role:

 **Government**	• Offer feedback to the implementers about the uncertain parameter combinations and ranges of variation. • Monitor the understandability of the vulnerability analysis, either through visualisations or scenario discovery.
 **Funder**	• Provide general support to the implementers. • Serve as enabling agents to exchange knowledge between the implementers and other experts.
 **Implementer**	• Deploy experiments in the available models. • Communicate findings to stakeholders on the early vulnerability analysis versions. • Understand the key insights that need to be extracted with more sophisticated scenario discovery algorithms. • Present findings, ensuring a high level of understandability by checking with government counterparts.

Main product:

- Preliminary results of the exploratory modelling.
- Understanding why Xs and Ls cause a strategy to succeed or fail through visualisations or scenario discovery approaches.

NDC-LTS alignment tip:

- Visualisations should reflect data points across the NDC update periods and potentially incorporate an NDC-specific scenario.
- Explore the opportunity to see and compare the assumptions of the country's latest NDC.

Step 7: Second workshop – results integration

The methodology progresses to a second participatory workshop, reuniting the first workshop participants to refine the initial inputs and evaluate the impacts. This workshop, segmented into a plenary session for presenting national and sectoral results and interactive working groups for in-depth discussions, focuses on transforming scenarios and modelling outcomes into actionable insights. Through collaborative dialogue, participants assess risks, vulnerabilities, and policy implications, ensuring a comprehensive exploration of strategies for future planning. This structured, inclusive approach aims to inform and influence decision-making processes.

Activity 7.1: Plan the workshop logistics

For the second workshop, select a venue based on attendance and send invitations to stakeholders listed in Activity 3.3. Create a detailed agenda with all activities, breaks, and discussion spaces. Similar to Activity 3.4, key agenda items include:

- ☐ **Participant registration:** Set up stations at the entrance for attendees to register and provide information, such as employment details and demographic background. Aim to distribute participants from the same entity across different tables.
- ☐ **Protocol opening:** Reserve time for speeches by high-level officials to influence the project's direction.
- ☐ **Presentation of objectives and preliminary results:** Share the initial results, emphasising key findings from the BAU and mitigation scenarios using graphs and figures. Focus on converting computational results into actionable insights, discussing risks and vulnerabilities in the country's decarbonisation strategy.
- ☐ **Space for dialogue:** Allow time for questions and discussions regarding the results.
- ☐ **Collaborative table sessions:** Set up tables with moderators to guide discussions, encouraging participants to document their insights for collective review.
- ☐ **Conclusion and insight sharing:** Groups share key takeaways and suggestions, with a spokesperson for each group presenting to all attendees.
- ☐ **Closure and next steps:** Conclude the workshop by outlining future project steps.

This structure ensures organised, productive discussions and collective insight generation for strategic planning.

Activity 7.2: Create engaging workshop materials

Compile outcomes from scenario creation, exploratory modelling, and scenario discovery, and present materials in an engaging manner, as illustrated in Activities 4.4 and 6.6. Craft questions and activities to reflect participant profiles and research goals. Provide printed summaries of scenario narratives and result graphs for use during table sessions. For instance, in Ecuador, an analysis only exploring variations on the Ls was presented to discuss the variations of uncertain policy targets like transport electrification, percentage of public transport use, percentage of forest cover, among others. This allowed stakeholders to understand the implications of lower or higher ambitions without the exogenous uncertainties. Finally, in preparation for the workshop, equip moderators with a computer for presentation access, facilitating discussions and analysis.

What should the presentation include?

- Previous work
- The methodology
- National results
- Sectoral results
- •Co-creation activity explanation
- Wrap-up and next steps

Activity 7.3: Execute the workshop

Follow the suggestions from the first workshop (activities 3.3 to 3.8). In this workshop, you can have the same type of activities with different guiding questions, focusing on the "how" to improve results.

Activity 7.4: Workshop wrap-up

Create and share a post-workshop concept note that summarises the workshop's insights. Include key takeaways, participants, agreements, and areas requiring further. Clearly outline the next steps and expectations following the workshop. This includes any follow-up meetings, data submissions, or additional research required. Share this note with all participants.

Key tasks by role:

 **Government**	• Assist the implementers with logistical aspects, review the guest list, and send invitations. • Take ownership of the methodology. • Review and give feedback on the different products: a pre-workshop concept note (agenda and workshop plan), a slide deck for the second workshop, and a concept note.
 **Funder**	• Closely support the technical team and communicate with the government through this process. • Review and give feedback on the different products: a pre-workshop concept note (agenda and workshop plan), a slide deck for the second workshop, and a concept note.
 **Implementer**	• Confirm which stakeholders will participate. • Ensure methodological presentation content is accessible to stakeholders (e.g., explain technical jargon, key definitions, methodology basics, context, etc.) • Prepare a script for moderators anticipating technical questions to keep the answers consistent. • In the post-workshop report, capture any actions emerging from the workshop and follow up with relevant stakeholders on these potential actions.

Main product:

- Pre-workshop concept note
- Slide deck for the second workshop
- Workshop concept note
- Post-workshop 2 concept note shared for feedback gathering

NDC-LTS alignment tip:

- Share a list of stakeholders from previous NDC formulations to include them in the LTS workshops as well.
- Translate the outcomes from the workshop into policies on actions needed on the short term to achieve the long-term benefits.

Step 8: Improve the results to address new concerns

Activity 8.1: Review and update the XLRM matrix

In Step 8, the focus shifts to refining and updating the results based on the insights gained from the workshops and the feedback from the government counterparts and funders. This activity is pivotal in ensuring the methodology remains aligned with the evolving knowledge and project objectives. The aim is to produce more nuanced and accurate results that can inform robust decision-making effectively.

Activity 8.2: Prioritize elements for analysis

As the project evolves, it may be clear that not all components of the XLRM matrix need immediate analysis, with some aspects better reserved for a more detailed study later. This step focuses on prioritizing elements for current in-depth analysis versus those for future examination, in order to optimize resource allocation. In expanding modelling tools to meet new requirements, it is important to:

- Communicate with stakeholders about how new requirements will be met, clarifying that not all updates require complex modifications.
- Determine if the revised XLRM matrix needs new models or capabilities for mapping uncertainties and levers to metrics, and opt for model adjustments or new, simpler models only when necessary and cost-effective.
- Consider existing work or tools with community support for new models, potentially delegating tasks to specialized local teams.
- Balance model complexity to ensure stakeholders can understand results, adjusting complexity based on the need for clarity or detail in the decision-making process.

Activity 8.3: Update base case scenarios

Update base case scenarios with the latest data and insights for accurate comparisons against alternative scenarios. This adjustment is often critical as initial scenarios might not fully capture stakeholder priorities and the presentation of scenarios frequently prompts requests for assumption changes. To manage model changes effectively:

- Collect input from all stakeholders before making modifications.
- Create a consolidated list of feasible changes and communicate to stakeholders, allowing for feedback to ensure understanding and agreement. If there is disagreement on quantitative parameters, consider creating a new scenario to reflect differing views or use an exploratory modelling approach to include previously unconsidered possibilities.

- Avoid repetitive changes by organising feedback collection efficiently and balancing flexibility with project momentum.
- Maintain clear version control for software, data inputs, and assumptions to track changes systematically.

Activity 8.4: Update the exploratory modelling results and scenario discovery

In exploring and discovering scenarios dependent on the base case results, the project team assesses how different variables and assumptions affect the scenarios, which is crucial for evaluating the robustness of strategies under varied conditions. This exploration offers insights into possible outcomes, allowing adjustments based on stakeholder feedback. Key principles for this activity include:

- Prioritise identifying key trade-offs and simplifying the exploratory modelling to include only impactful suggestions.
- Collect all feedback before making changes, mirroring Activity 8.3's approach due to the high computational cost of experiments.
- Seize any opportunity to run the model under multiple variations at lower computational costs, particularly for necessary updates to correct errors or resolve inconsistencies, ensuring efficient and accurate modelling processes.

Activity 8.5: Develop a straightforward narrative

To communicate the findings effectively, the project team should develop a narrative that presents the scenario discovery results that stakeholders can engage with. A well-crafted narrative helps stakeholders, including the government counterparts and funders, understand the implications of different scenarios and the associated uncertainties. The following questions can help the implementers define the narrative:

- Are the analytical findings intuitive or expected according to the historical knowledge of the system?
- Are the visualisations of results capturing the metrics and insights collected in the past two workshops?
- Does the narrative communicate the possibilities about the consequences of policy levers in different uncertain conditions?
- Does the narrative convey the key trade-offs of strategies and leave room for stakeholder deliberation?
- Is the evidence generated by the model compatible with the understanding of a sector transition, according to the relevant body of literature and expert insights gathered in the workshops and bilateral meetings?

Activity 8.6: Presentation of the second set of simulations

Present the scenarios to the funders and government counterparts, using clear visualisations to communicate simulation results and narratives. While detailed visuals may suit specialised audiences, ensure simplicity for strategic deliberations involving diverse stakeholders. Focus on conveying the core implications of a robust strategy—comprising technology, infrastructure investments, and regulatory reforms effective under various uncertain conditions—to facilitate broad understanding and feedback.

Key tasks by role:

Implementer

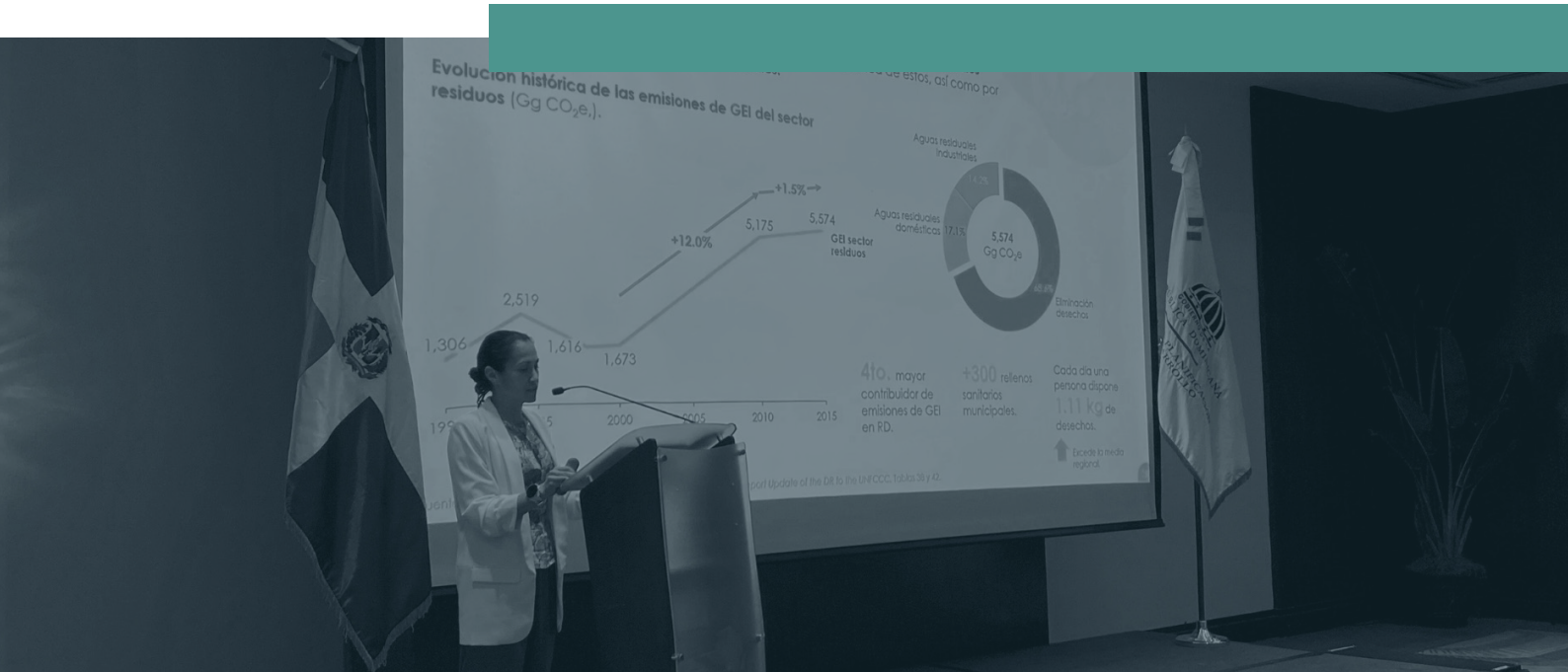
- Include all the recommendations collected in the feedback process and if they were not included, generate an attached document with due justification.

Main product:

- Updated base scenarios, exploratory modelling, and scenario discovery
- Presentation with results

NDC-LTS alignment tip:

- The updated analysis should highlight short-term results to support the NDCs and other national processes underway.



Step 9: Third workshop – Disseminating final results

In this step, plan the third and final workshop. Follow the suggestions and activities presented in Step 3 and Step 7.

Activity 9.1: Plan the workshop logistics

Select a venue appropriate for the number of attendees, favouring in-person meetings for enhanced interaction. Prepare a pre-workshop note detailing objectives and expectations. Send invitations to a diverse group across government, organisations, academia, businesses, NGOs, and include experts. Organise a schedule of activities, breaks, and discussions. Proper preparation and adherence to plan optimise workshop outcomes.

What should the presentation include?

- Present previous work
- Explain the methodology
- Final results (total and sectoral)
- Co-Creation activity explanation
- Wrap-up and next steps regarding the execution of the LTS
- Wrap-up and next steps

Activity 9.2: Create engaging workshop materials

Compile the final results from scenario creation and exploratory modelling and present them with tailored questions and engaging activities suited to participant profiles and research goals. Print results and graphs for discussions and equip moderators with a computer for presentation flexibility, enhancing interactions and understanding during the workshop.

Activity 9.3: Develop the workshop

Follow the suggestions from Workshop I and II. In this workshop, you can have the same type of activities with different guiding questions that focus on the final results.

Activity 9.4: Workshop wrap-up

Create and share a post-workshop concept note that summarises the workshop's insights. Include key takeaways, participants, agreements, and areas requiring further. Clearly outline the next steps and expectations following the workshop. This includes any follow-up meetings, data submissions, or additional research required. Share this note with all participants.

Key tasks by role:

 **Government**	• Assist the implementers with logistical aspects, review the guest list, and send invitations. • Take ownership of the methodology. • Review and give feedback to the different products: pre-workshop concept note (agenda and plan of the workshop), a slide deck for the third workshop, and workshop concept note.
 **Funder**	• Closely support the technical team and communicate with the government through this process. • Review and give feedback to the different products: pre-workshop concept note (agenda and plan of the workshop), slide deck for the third workshop, and workshop concept note.
 **Implementer**	• Confirm which stakeholders will participate. • Ensure methodological presentation content is accessible to stakeholders (e.g., explain technical jargon, definitions, methodology, context, etc.) • Prepare a script for moderators anticipating technical questions to keep the answers consistent. • In the post-workshop report, capture any actions emerging from the workshop and follow up with relevant stakeholders.

Main product:

- Pre-workshop concept note
- Slide deck for the third workshop
- Workshop concept note

NDC-LTS alignment tip:

- The workshop should lead to a clear presentation of short-term actions necessary to deliver long-term benefits.

Step 10: Produce final results and the final report

Activity 10.1: Address any additional feedback

Create a new set of simulations based on the inputs from the third workshop including new tools and data when it applies.

Activity 10.2: Review results

The technical team will thoroughly assess the results, making necessary model adjustments. The aim is to create a cohesive simulation set that effectively accounts for uncertainties. Based on the insights gained from this review, fine-tune the experiment and prepare comprehensive materials to present to both the government counterparts and funders.

Leveraging the prior findings and achievements, develop informative materials showcasing progress and outcomes catering to the funder and the government's requirements and expectations. By synergising the input provided by the funders and government counterpart with the team's collective expertise, facilitate the refinement of the results, ultimately yielding an enhanced collection of simulations.

Activity 10.3: Document feedback and assumptions

Thoroughly document the feedback from the workshops and the underlying assumptions made throughout the project. Beyond the immediate results, emphasise the importance of documentation and scalability.

Activity 10.4: Produce definitive results

In the final step of this guide, the definitive results are produced. Present the base case and exploration (sensitivity) results as important insights and provide a comprehensive view of the analysis. Additionally, in the final report, highlight the significance of Applied Scenario Discovery as a nuanced perspective that enriches the narrative. Ensure the project's documentation is comprehensive and transparent, allowing for replication in other sectors, projects, or future updates.

Activity 10.5: Disseminate the results

Throughout the project, remember the critical role of documenting assumptions and publishing data, assumptions, results, and tools under an open license. This openness fosters reusability for future assessments and contributes to the broader knowledge-sharing ecosystem.

Activity 10.6: Ensure broader policy alignment

Ensure the results can support broader policy alignment. The results produced must allow policymakers to feed the updating process of NDCs as they are a key intermediary step to reach the mid-century goal. Furthermore, and ideally, an LTS need to support the creation or revising of National Development Plans. It is crucial to highlight how the NDCs and National Development Plans must align with the LTS to ensure cohesive and integrated climate action.

Key tasks by role:

 **Government**	• Participate in reviewing and validating the documentation, ensuring it aligns with the objectives and expectations. • Encourage and endorse the practice of open knowledge sharing, emphasising its importance and potential benefits for future assessments and decision-making processes.
 **Funder**	• Ensure that adequate resources and support are available to facilitate thorough documentation and the production of the final results. • Actively engage in the review process, providing valuable feedback and insights on the documentation and final results, as needed.
 **Implementer**	• Lead the process of compiling and presenting the final results. Assemble all relevant data, findings, and insights into a comprehensive report. • Document and update the assumptions made throughout the project. Ensure that any changes or revisions are well-documented for transparency. • Publish data, assumptions, results, and tools under open licenses to contribute to a broader ecosystem of reusable resources.

Main product:

- Final report
- Slide deck with final results

NDC-LTS alignment tip:

- Develop and disseminate recommendations relevant to inform the NDC update and/or implementation, as well as other relevant national policies.

3 FINAL RECOMMENDATIONS FOR YOUR PROJECT

This guide offered an experience-based framework for implementing a well-established RDM methodology. Recognising that each case is unique and influenced by specific circumstances and country particularities, this guide provides a solid foundation of recommendations for successfully deploying RDM. These final suggestions hope to enrich the understanding and application of the guide, ensuring that RDM is effectively tailored to your specific needs and contexts.

- **Incorporate comprehensive case studies:** Enhance the guide with detailed case studies from Latin America and the Caribbean. These examples should vividly illustrate the application of RDM, highlighting the strategies employed, the challenges faced, and the innovative solutions developed. This will offer practical insights and serve as a learning tool for understanding the nuances of RDM in real-world settings.
- **Emphasize cultural and contextual adaptation:** Adapting RDM to each region's unique cultural, economic, and political landscapes. Encourage practitioners to engage deeply with local communities to ensure that RDM strategies are culturally sensitive, contextually relevant, and resonate with local values and needs.
- **Focus on continuous learning and adaptive management:** Highlight the dynamic nature of RDM. RDM strategies should be regularly reviewed and adapted as external conditions and internal understandings evolve. This ensures that these strategies remain effective and relevant over time.
- **Prioritise capacity building and training:** Extensively train programs for all stakeholders involved in RDM. This includes technical aspects and skills in stakeholder engagement, communication, and collaborative decision-making.
- **Advocate for collaboration and multi-sector partnerships:** Form solid partnerships across different sectors. Collaborations between governments, NGOs, the private sector, and international organisations can provide diverse perspectives and resources, enhancing the efficacy and resilience of RDM strategies.
- **Implement strong monitoring and evaluation frameworks:** Develop of robust monitoring and evaluation frameworks. These should include clear success metrics and regular assessment mechanisms to track the effectiveness of RDM strategies and inform necessary adjustments.

- **Leverage technology and data analytics:** In an era dominated by technology, underline the role of advanced data analytics and modelling tools in enhancing RDM. These technologies can significantly improve scenario planning and decision-making processes.
- **Integrate comprehensive risk management:** Integrate risk management into RDM, encompassing the identification, assessment, and mitigation of potential risks. This proactive approach is vital for ensuring the robustness of RDM strategies.
- **Engage in policy advocacy and regulatory framework development:** Engage with policymakers to establish supportive regulations and policies. This advocacy is crucial for creating an enabling environment for RDM.
- **Ensure transparency and public engagement:** Stress the importance of clear and transparent communication. Building public trust and support through effective communication is key to the success of RDM initiatives.
- **Align strategies with sustainable development goals:** Align RDM strategies with long-term sustainability goals. Decision-making should be forward-looking, considering the impacts on future generations.
- **Offer guidance on financial strategies and resource mobilization:** Provide detailed advice on financial planning and resource mobilisation. This includes identifying potential funding sources and ensuring efficient, transparent allocation of resources.

In addition, collaborative efforts are critical in successfully implementing RDM. Governments can initiate and foster collaboration with multilateral organisations and academia through formal invitations for partnerships, organising workshops and conferences, or directly engaging in consultative processes. To facilitate this, establishing a dedicated platform for collaboration is crucial. Such a platform should enable government officials, multilateral organisations, academic institutions, and other stakeholders to share insights and expertise. This collaborative approach, which may require a special mandate due to the need for interministerial coordination, can significantly enhance the effectiveness of RDM.

On this collaborative platform, stakeholders can employ RDM methods to jointly identify needs and gaps in existing policy frameworks and strategic planning processes. Institutions can also approach the government to discuss funding mechanisms for research that informs these needs and gaps. Implementing an RDM project ideally involves a well-coordinated effort between governments, multilateral organisations, academia, and other stakeholders. Key components of this implementation include:

- **Capacity building:** Train local teams and stakeholders to enhance their skills and knowledge in RDM. Building capacity is crucial for the sustainability and adaptability of the methodology, particularly in dynamic and diverse contexts.
- **Research and development:** Invest in research to customise RDM methodology to the country or region's contextual needs and challenges. This helps ensure that RDM strategies are relevant and effective.
- **Stakeholder engagement:** Organise workshops and consultations for a participative approach. Integrating insights from various sectors and backgrounds can lead to more comprehensive and inclusive RDM strategies.
- **Knowledge product creation:** Develop guides, tools, and resources that are accessible and practical. These materials should cater to policymakers, practitioners, and other stakeholders, providing them with the necessary information and tools for effective decision-making.
- **Monitoring and evaluation:** Implement mechanisms to monitor and evaluate the effectiveness and impact of RDM for continuous improvement. This also allows adaptation of emerging trends and challenges, keeping RDM process relevant and effective.

The guide in Section 2 explicitly addresses research and development, stakeholder engagement, and knowledge product creation. However, the other components– namely capacity building, monitoring, and evaluation– may require additional funding. These components are crucial for a more effective adoption of RDM tools in both current and future projects. In some instances, capacity building is initiated before the start of the LTS design, as was the case in Guatemala. In other scenarios, capacity building is integrated within the projects themselves. This often occurs when local universities or consultants work alongside experts to transfer knowledge to local teams during the project, such as in the Dominican Republic.

Guatemala

The Guatemala project, currently ongoing, was preceded by a local capacity building project where the University of Costa Rica transferred its modeling knowledge to two local universities.

Dominican Republic

In Dominican Republic, a local university received software tools, data, and training on the methods applied during RDM project.

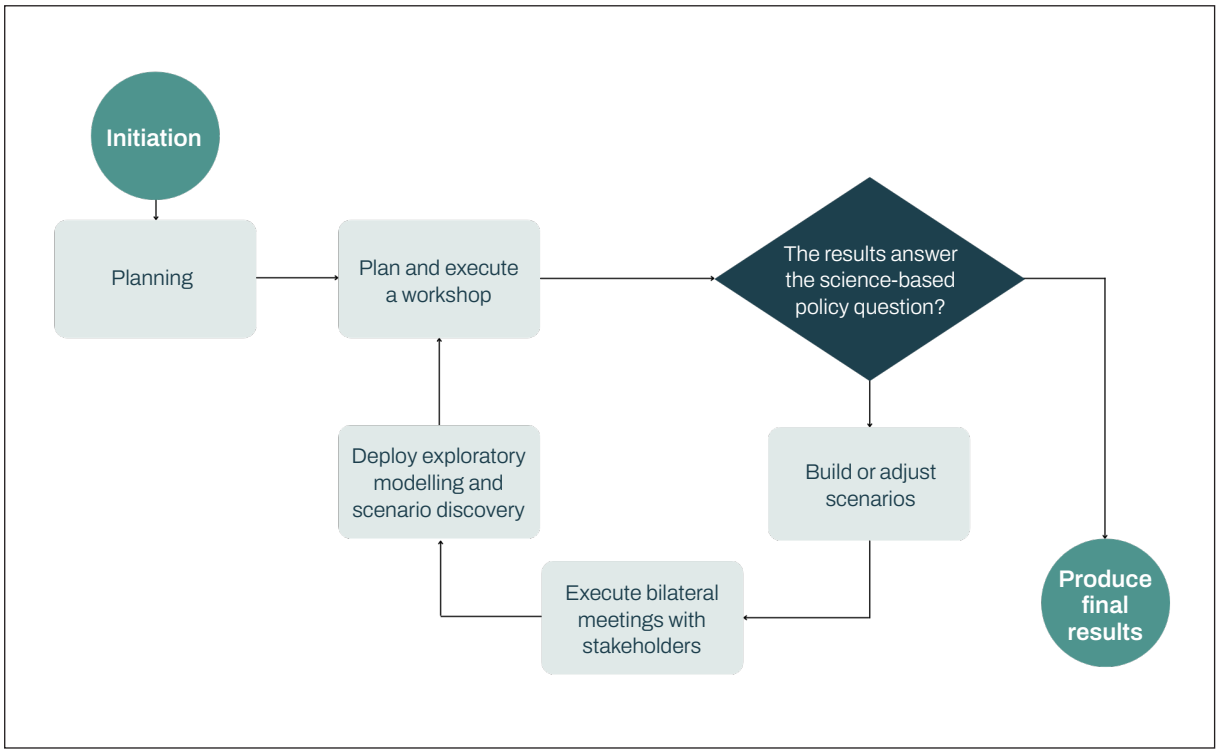
Be prepared for the possible need to adjust the guide.

This guide emphasises the role of RDM in supporting the development of an LTS. It emphasises the management of uncertainties and differing viewpoints to reach consensus in the decision-making processes. The principle of RDM is to work with the available tools and information to make informed decisions, recognising that inaction has consequences.

The technical nuances of exploratory modelling and scenario discovery are comprehensively covered, focusing on effective technology transfer. This will ensure that future users of RDM outputs can maintain, adapt, and apply these tools and frameworks in ongoing policy discussions and decision-making processes.

Diagram 10 shows a more iterative implementation of this guide, recognising that countries or regions may require more scenarios, bilateral meetings, exploratory modelling scenario discovery implementations, and workshops. It is critical to understand the iterative nature of the RDM methodology, drawing on past experiences in Latin America and the Caribbean. This guide has advocated for at least three iterations to ensure effective outcomes.

Diagram 10: Project template process for deploying an RDM project



4 ABBREVIATIONS

AFOLU	Agriculture, forestry, and other land uses
BAU	Business As Usual
D2D	Data-to-Deal
DAP	Dynamic Adaptive Planning
DAPP	Dynamic Adaptive Policy Pathways
DMDU	Decision Making Under Deep Uncertainty
EOA	Engineering Options Analysis
GHG	Greenhouse Gas Emissions
IDB	Interamerican Development Bank
IG	Info-Gap Decision Theory
ILO	International Labour Organization
IPCC	ntergovernmental Panel on Climate Change
L	Policy Levers
LT-LEDS	Long Term Low Emissions Development Strategy
LTS	Long Term Strategies
M	Measures or Performance metrics
NDC	Nationally Determined Contributions
NGO	Non-governmental organization
R	Relationships or Models
RDM	Robust Decision Making
ToRs	Terms of Reference
UNFCCC	United Nations Framework Convention on Climate Change
USD	US Dollars
X	Exogenous uncertainties
XLRM	Matrix with Uncertainties, Levers, Relationships, and Measures

5 GLOSSARY

Exploratory modelling: An approach involving computer models to gain insights into complex systems and uncertainties, mainly when data is limited or there is high uncertainty. Models are constructed and manipulated to explore scenarios, test assumptions, and understand potential outcomes, aiding decision-makers in understanding complex systems.

Long-Term Strategies: Comprehensive and forward-looking strategies developed by countries under Article 4.19 of the Paris Agreement. A Long-Term Strategy (LTS) outlines a nation's vision and pathways for mitigating greenhouse gas emissions (GHG) and addressing climate change impacts over decades, typically projecting to 2050. These strategies are key in achieving the Agreement's goals and aligning climate action with national development objectives and economic growth. As per the UNFCCC LT-LEDS synthesis report, the large majority of LT-LEDS submitted so far include adaptation elements and address climate change holistically.

Scenarios: Scenarios are a set of plausible and internally consistent narratives or stories that describe different ways the future could unfold. These narratives are constructed to capture a range of possible future conditions, events, or developments that could impact a decision or a system.

Uncertainty: Uncertainty in decision-making and modelling denotes incomplete knowledge, unpredictability, and expert disagreement regarding future events, variable values, outcomes, or conditions. It arises from our limited understanding of complex systems and the myriad factors influencing them. This concept manifests in two primary forms: aleatory uncertainty, which stems from inherent randomness, and epistemic uncertainty, rooted in gaps in knowledge.

Pathways: Pathways in decarbonization refer to the various strategies, methods, and steps taken to reduce or eliminate carbon emissions. These pathways often involve a combination of technological innovation, technological deployment, policy measures, behavioural changes, and economic shifts, all aimed at transitioning towards a low-carbon or net zero emissions future. The concept of pathways in decarbonization emphasizes the need for a multi-faceted approach, recognizing that no single solution can address the complex challenge of reducing greenhouse gas emissions.

Participatory approach: A method of decision-making that emphasizes the involvement and collaboration of relevant individuals or groups.

Performance metrics: Quantifiable measures used to evaluate the effectiveness or performance of different strategies, enabling an objective assessment and comparison of outcomes.

Robust Decision Making: Flexible and systematic method used to support policy and strategy development by exploring multiple possible futures and assessing strategies under deep uncertainty while adopting a participatory approach.

Scenario discovery: Scenario discovery is a process that employs statistics and data-mining algorithms to identify policy-relevant clusters or scenarios in large, multi-dimensional databases of simulation model results. It aids decision-makers in pinpointing conditions or combinations of factors that lead to specific outcomes, crucial for risk assessment, strategic planning, and decision-making under deep uncertainty. This approach helps understand and quantify trade-offs among different strategies by highlighting the key drivers of system behaviour.

Stakeholder engagement: The active involvement of a diverse range of individuals, organizations, and groups who have a vested interest or influence in the policy or decision-making process, fostering collaboration and interaction to achieve informed and inclusive outcomes.

Vulnerability analysis: Examining the potential weaknesses or risks of specific strategies or decisions.

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