



New **E**nabling **V**isions and Tools for **E**nd-use**R**s and stakeholders thanks to a common **M**Odeling app**R**oach towards a Climat**E** neutral and resilient society

D7.1 ICT toolkit design and architecture

November 2023



This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101056858.

Document history

| | |
|-------------------------------|--|
| Project Acronym | NEVERMORE |
| Project ID | 101056858 |
| Project title | New Enabling Visions and Tools for End-useRs and stakeholders thanks to a common MOdeling appRoach towards a ClimatE neutral and resilient society |
| Project coordination | Fondazione Bruno Kessler (Italy) |
| Project duration | 1 st June 2022 – 31 st May 2026 |
| Deliverable Title | D7.1 ICT toolkit design and architecture |
| Type of Deliverable | R – Document, Report. |
| Dissemination level | PU – Public |
| Status | Final |
| Version | 1.0 |
| Work package | WP7 – Analysis of climate change impacts and risk at case studies |
| Lead beneficiary | CARTIF |
| Author(s) | Iván Ramos (CARTIF), Carlos de la Cruz (CARTIF), Francisco Javier Miguel (CARTIF), Sara Barilari (CARTIF) Alessandra Nuzzo (CMCC), Paola López (UVa), Alexandru Visan (SIMAVI) |
| Reviewer(s) | Paolo Massa (FBK), Rita Di Stefano (RINA), Alessia Torre (FBK), Iván Ramos (CARTIF) |
| Due date of delivery | 30/11/2023 |
| Actual submission date | 29/11/2023 |

| Date | Version | Contributors | Comments |
|------------|---------|---|---|
| 19/09/2023 | 0.1 | Carlos de la Cruz (CARTIF) | Table of Contents (ToC) |
| 31/10/2023 | 0.2 | Carlos de la Cruz (CARTIF) and Francisco Javier Miguel (CARTIF) | First draft of A&M catalogue and EU-scale tool respectively |
| 01/11/2023 | 0.3 | Sara Barilari (CARTIF) | Requirements from previous deliverables |
| 10/11/2023 | 0.4 | Iván Ramos (CARTIF) | First draft of the Case study tool |
| 14/11/2023 | 0.5 | Carlos de la Cruz (CARTIF), Francisco Javier Miguel (CARTIF) and Iván Ramos (CARTIF) | First draft of the Gamification tool. Improved version of the EU-Scale tool. First draft of the general ICT toolkit architecture. |
| 17/11/2023 | 0.6 | Iván Ramos (CARTIF) | First completed version of the deliverable shared with reviewers |
| 28/11/2023 | 0.7 | Carlos de la Cruz (CARTIF), Francisco Javier Miguel (CARTIF) and Sara Barilari (CARTIF) | Integration of comments from reviewers |
| 29/11/2023 | 1.0 | Alessia Torre (FBK), Iván Ramos (CARTIF) | Final editing and submission |



New Enabling Visions and Tools for End-useRs and stakeholders thanks to a common
MOdeling appRoach towards a ClimatE neutral and resilient society

Copyright ©2022 NEVERMORE Consortium Partners. All rights reserved.

NEVERMORE is a Horizon Europe Project supported by the European Commission under contract No.101056858. For more information on the project, its partners, and contributors please see NEVERMORE website. You are permitted to copy and distribute verbatim copies of this document, containing this copyright notice, but modifying this document is not allowed. All contents are reserved by default and may not be disclosed to third parties without the written consent of the NEVERMORE partners, except as mandated by the European Commission contract, for reviewing and dissemination purposes. All trademarks and other rights on third party products mentioned in this document are acknowledged and owned by the respective holders. The information contained in this document represents the views of NEVERMORE members as of the date they are published. The NEVERMORE consortium does not guarantee that any information contained herein is error-free, or up to date, nor makes warranties, express, implied, or statutory, by publishing this document.

Abbreviations and acronyms

| Acronym | Description |
|------------|--|
| SDG | Sustainable Development Goals |
| ICT | Information and Communication technologies |
| AMS | Adaptation and mitigation solution |
| ORM | Object-Relational Mapping |
| WP | Work Package |
| MEDEAS | Modelling the Renewable energy transition in Europe |
| LOCOMOTION | Low carbon society: An enhance modelling tool for the transition to sustainability |
| A&M | Adaptation and Mitigation |
| ECVs | Essential Climate Variables |
| IAM | Integrated Assessment Model |
| EST | EU-Scale tool |

Table of Contents

| | |
|---|-----------|
| DOCUMENT HISTORY | 1 |
| ABBREVIATIONS AND ACRONYMS | 3 |
| TABLE OF CONTENTS | 4 |
| LIST OF FIGURES | 6 |
| LIST OF TABLES | 7 |
| EXECUTIVE SUMMARY | 10 |
| 1. INTRODUCTION | 10 |
| 1.1. Purpose of the document..... | 11 |
| 1.2. Structure of the document..... | 11 |
| 2. GLOSSARY OF TERMS | 12 |
| 3. METHODOLOGY FOR THE DESIGN AND DEVELOPMENT OF THE NEVERMORE ICT TOOLKIT | 13 |
| 3.1. Start-up phase | 13 |
| 3.2. Design | 13 |
| 3.3. Implementation phase | 14 |
| 3.4. Deployment phase..... | 14 |
| 4. SUMMARY OF REQUIREMENTS IDENTIFIED IN PREVIOUS DELIVERABLES | 14 |
| 5. HIGH-LEVEL ARCHITECTURE | 20 |
| 5.1. Description of architecture layers and components..... | 21 |
| 5.1.1. Data layer | 21 |
| 5.1.2. Business Logic Layer | 22 |
| 5.1.3. Application Layer..... | 23 |
| 5.2. Interfaces identification | 25 |
| 5.3. Performance, security and manageability..... | 25 |
| 5.3.1. Performance..... | 25 |
| 5.3.2. Security..... | 26 |
| 5.3.3. Manageability..... | 26 |
| 5.4. Synergies and Trade-offs between tools..... | 26 |
| 6. A&M CATALOGUE TOOL | 27 |
| 6.1. Introduction | 27 |
| 6.2. Requirements | 27 |
| 6.2.1. Functional requirements..... | 28 |
| 6.2.2. Non-functional requirements | 29 |
| 6.3. Use Cases | 29 |

- 6.3.1. A&M Catalogue Use Cases Diagram..... 30
- 6.4. Mock-ups 31
- 6.5. Architecture 34
 - 6.5.1. Selected Technologies..... 34
 - 6.5.2. Tool Architecture..... 35
- 7. CASE STUDY TOOL..... 35**
 - 7.1. Introduction 35
 - 7.2. Requirements 35
 - 7.2.1. Functional requirements 36
 - 7.2.2. Non-functional requirements 36
 - 7.3. Use Cases 37
 - 7.3.1. Use Cases Diagram for the case study tool 38
 - 7.4. Mock-ups 39
 - 7.5. Architecture 43
 - 7.5.1. Selected Technologies..... 43
 - 7.5.2. Tool Architecture..... 44
- 8. EU-SCALE TOOL..... 44**
 - 8.1. Introduction 44
 - 8.2. Requirements 44
 - 8.2.1. Functional requirements 45
 - 8.2.2. Non-functional requirements 45
 - 8.3. Use Cases 46
 - 8.3.1. Use Cases Diagram for the case study tool 47
 - 8.4. Mock-ups 48
 - 8.5. Architecture 52
 - 8.5.1. Selected Technologies..... 53
 - 8.5.2. Tool Architecture..... 53
- 9. GAMIFICATION TOOL 54**
 - 9.1. Introduction 54
 - 9.2. Requirements 54
 - 9.2.1. Functional requirements 54
 - 9.2.2. Non-functional requirements 55
 - 9.3. Use Cases 56
 - 9.3.1. Use Cases Diagram for the gamification tool 57
 - 9.4. Mock-ups 58

| | | |
|------------|--|-----------|
| 9.5. | Architecture | 66 |
| 9.5.1. | Selected Technologies..... | 66 |
| 9.5.2. | Tool Architecture..... | 66 |
| 10. | DESIGN VALIDATION WITH PROJECT PARTNERS | 67 |
| 10.1. | Case study tool..... | 67 |
| 10.2. | A&M catalogue | 69 |
| 10.3. | Gamification tool | 70 |
| 11. | CONCLUSIONS..... | 71 |
| 12. | REFERENCES..... | 72 |
| 13. | ANNEXES | 73 |
| 13.1. | Annex I: ICT Toolkit General Use Cases | 73 |
| 13.2. | Annex II: A&M Catalogue Tool Use Cases..... | 75 |
| 13.3. | Annex III: Case Study Tool Use Cases..... | 81 |
| 13.4. | Annex IV: EU-Scale Tool Use Cases | 85 |
| 13.5. | Annex V: Gamification Tool Use Cases | 90 |

List of Figures

| | | |
|------------|--|----|
| Figure 1. | NEVERMORE high-level architecture. | 21 |
| Figure 2. | Main page of the NEVERMORE ICT toolkit including the login, register and information on the tools..... | 23 |
| Figure 3. | Main page of the NEVERMORE ICT toolkit with the register form. | 24 |
| Figure 4. | Main page of the NEVERMORE ICT toolkit with the password recovery form. | 24 |
| Figure 5. | Interface for tool selection..... | 24 |
| Figure 6. | NEVERMORE high-level architecture with the identification of the different interfaces. | 25 |
| Figure 7. | Generalized Actor Diagram for the A&M Catalogue tool..... | 31 |
| Figure 8. | Use case diagram for the A&M catalogue..... | 31 |
| Figure 9. | Initial interface of the A&M catalogue..... | 32 |
| Figure 10. | Initial view with the dropdown menu expanded. | 33 |
| Figure 11. | Interface to visualize the taxonomy solution implemented for the measures..... | 33 |
| Figure 12. | A&M interface to review and download the factsheets..... | 34 |
| Figure 13. | Monolithic architecture of the A&M Catalogue..... | 35 |
| Figure 14. | Generalized Actor Diagram for the NEVERMORE case study tool. | 38 |
| Figure 15. | Use case diagram for NEVERMORE case study tool..... | 39 |
| Figure 16. | Home page of the NEVERMORE Case Study tool..... | 40 |
| Figure 17. | Home page of the NEVERMORE Case Study tool with a dropdown menu expanded. | 40 |
| Figure 18. | Interface for case evaluation. It includes functionalities for sector and challenges assessment..... | 41 |
| Figure 19. | Interface of the Case Study tool to visualize ECVs and hazards..... | 41 |
| Figure 20. | Interface to evaluate assets, vulnerabilities and risks. | 42 |

| | |
|---|----|
| Figure 21. Interface for vulnerabilities and risk comparison by sector..... | 42 |
| Figure 22. Policy prioritization interface using a guided questionnaire approach. | 43 |
| Figure 23. Policy recommendations interface. | 43 |
| Figure 24. Monolithic architecture of the Case Study tool. | 44 |
| Figure 25. Generalized Actor Diagram for the NEVERMORE EU-scale tool. | 47 |
| Figure 26. Use case diagram for NEVERMORE EU-Scale tool..... | 47 |
| Figure 27: Main interface for the EU Scale tool. | 48 |
| Figure 28: Main interface for the EU Scale tool with the dropdown menu visible..... | 48 |
| Figure 29: Create a new scenario using the EU-scale tool. | 49 |
| Figure 30: Interface for the list of scenarios with only public scenarios selected. | 49 |
| Figure 31: Interface for the list of scenarios with only private scenarios selected..... | 50 |
| Figure 32: Interface for the list of scenarios with both (public and private scenarios) available for comparison..... | 50 |
| Figure 33: Main page for policy selection in the EU-scale tool..... | 51 |
| Figure 34: Design of the view for policy parametrization. | 51 |
| Figure 35: Design of the view for results evaluation using a selected scenario. | 52 |
| Figure 36: Interface to compare two scenarios. | 52 |
| Figure 37. Monolithic architecture of the EU-Scale tool..... | 54 |
| Figure 38. Generalized Actor Diagram for the NEVERMORE gamification tool. | 57 |
| Figure 39. Use case diagram for NEVERMORE gamification tool..... | 58 |
| Figure 40: Main interface for the Gamification tool. | 59 |
| Figure 41: Main interface for the Gamification tool with the dropdown menu expanded. | 59 |
| Figure 42: Interface for role selection..... | 60 |
| Figure 43: Interface for policy parametrization. | 60 |
| Figure 44: Interface for the mitigation results evaluation. | 61 |
| Figure 45: Interface for case study and hazard selection. | 61 |
| Figure 46: Interface for mitigation policies parametrization. | 62 |
| Figure 47: Interface for the visualization of the implementation of adaptation policies. | 62 |
| Figure 48: Interface for role selection as a team player. | 63 |
| Figure 49: Interface for policy parametrization as team player..... | 63 |
| Figure 50: Interface for the mitigation results evaluation as a team player..... | 64 |
| Figure 51: Interface for results comparison as a team player. | 64 |
| Figure 52: Interface for case study and hazard selection as a team player. | 65 |
| Figure 53: Interface for mitigation policies parametrization as a team player..... | 65 |
| Figure 54: Interface for results comparison in adaptation as a team player..... | 66 |
| Figure 55. Monolithic architecture of the Gamification tool. | 66 |
| Figure 56. Collected inputs for the Case Study tool..... | 68 |
| Figure 57. Collected inputs for the A&M catalogue tool. | 69 |
| Figure 58. Collected inputs for the Gamification tool..... | 70 |

List of Tables

| | |
|---|----|
| Table 1. Glossary of terms..... | 12 |
| Table 2. Legend for displaying the three different levels of addressing the requirements..... | 14 |

| | |
|--|----|
| Table 3. Requirements from case studies and experts for the A&M Catalogue Tool..... | 14 |
| Table 4. Requirements from case studies and experts for the EU-scale Tool..... | 16 |
| Table 5. Requirements from case studies and experts for the Case Study Tool..... | 18 |
| Table 6. Requirements from case studies and experts for the Gamification Tool..... | 19 |
| Table 7. Use Cases and description for the general toolkit. Detailed information: Section 13.1. | 23 |
| Table 8. Summary of the functional requirements for the NEVERMORE A&M Catalogue tool. | 28 |
| Table 9. Summary of the non-functional requirements for the NEVERMORE A&M Catalogue tool.... | 29 |
| Table 10. Identified Use Cases and description for the A&M catalogue tool. | 30 |
| Table 11. Summary of the functional requirements for the NEVERMORE Case Study tool. | 36 |
| Table 12. Summary of the non-functional requirements for the NEVERMORE Case Study tool..... | 37 |
| Table 13. List and use case description for NEVERMORE gamification tool. | 37 |
| Table 14. Functional requirements for EU Scale tool..... | 45 |
| Table 15. Non-functional requirements for EU Scale tool. | 45 |
| Table 16. Use cases for the EU Scale tool..... | 46 |
| Table 17. Functional requirements for the Gamification tool. | 54 |
| Table 18. Summary of the non-functional requirements for the NEVERMORE Case Study tool..... | 55 |
| Table 19. List and use case description for NEVERMORE gamification tool. | 56 |
| Table 20. ICT toolkit: UC1, Register as a tool user. | 73 |
| Table 21. ICT toolkit: UC2, Log into the tool. | 73 |
| Table 22. ICT toolkit: UC3, Recover password..... | 74 |
| Table 23. ICT toolkit: UC4, Tool selection..... | 74 |
| Table 24. A&M catalogue: UC0, Assessment using the tool. | 75 |
| Table 25. A&M catalogue: UC1, Search A&M Solutions. | 75 |
| Table 26. A&M catalogue: UC2, Submit Solution..... | 76 |
| Table 27. A&M catalogue: UC3, Navigate Cross-Sectoral Policies. | 76 |
| Table 28. A&M catalogue: UC4, Select AMS. | 77 |
| Table 29. A&M catalogue: UC5, Download Factsheet. | 78 |
| Table 30. A&M catalogue: UC6, Related AMS to challenges. | 78 |
| Table 31. A&M catalogue: UC7, Filter by Geographic and Climatic Areas..... | 79 |
| Table 32. A&M catalogue: UC8, Filter by Implemented Policies. | 79 |
| Table 33. A&M catalogue: UC9, Navigate to global tool..... | 80 |
| Table 34. A&M catalogue: UC10, Navigate to local tool. | 80 |
| Table 35. Case study tool: UC0, Case Study Selection. | 81 |
| Table 36. Case study tool: UC1, Evaluation of Case Study Data..... | 81 |
| Table 37. Case study tool: UC2, ECVs and hazard assessment. | 82 |
| Table 38. Case study tool: UC3, Assets/Vulnerability/Risk visualization. | 82 |
| Table 39. Case study tool: UC4, Vulnerability/Risk Sectoral comparison. | 83 |
| Table 40. Case study tool: UC5, Policy Priorities. | 84 |
| Table 41. Case study tool: UC6, Recommended policies. | 84 |
| Table 42. EU Scale tool: UC0, Assessment of the tool. | 85 |
| Table 43. EU Scale tool: UC1, Create new scenario. | 86 |
| Table 44. EU Scale tool: UC2, Scenario navigation..... | 86 |
| Table 45. EU Scale tool: UC3, Save scenario to file. | 87 |
| Table 46. EU Scale tool: UC4, Go back to main entrance..... | 87 |



| | |
|--|----|
| Table 47. EU Scale tool: UC5, Visualization of model assumptions. | 87 |
| Table 48. EU Scale tool: UC6, Saving scenarios. | 88 |
| Table 49. EU Scale tool: UC7, Simulation scaling. | 88 |
| Table 50. EU Scale tool: UC8, Scenario sharing between users. | 89 |
| Table 51. EU Scale tool: UC8, Interaction between users. | 89 |
| Table 52: EU Scale tool: UC9. Comparison of scenarios..... | 90 |
| Table 53. Gamification tool: UC0, Selection Tool Mode. | 90 |
| Table 54. Gamification tool: UC1, Role selection. | 91 |
| Table 55. Gamification tool: UC2, Mitigation Assessment..... | 92 |
| Table 56. Gamification tool: UC3,Mitigation Results. | 92 |
| Table 57. Gamification tool: UC4, Adaptation Assessment. | 93 |
| Table 58. Gamification tool: UC5, Policy selection..... | 94 |
| Table 59. Gamification tool: UC6, Adaptation Indicators. | 94 |
| Table 60. Gamification tool: UC7, Group/Role Selection..... | 95 |
| Table 61. Gamification tool: UC8, Team Mitigation Assessment..... | 96 |
| Table 62. Gamification tool: UC9, Team Mitigation Results. | 96 |
| Table 63. Gamification tool: UC10, Results Comparison Mitigation. | 97 |
| Table 64. Gamification tool: UC11, Team Adaptations Assessment..... | 98 |
| Table 65. Gamification tool: UC12, Team Policy Selection. | 98 |
| Table 66. Gamification tool: UC13, Results Comparison Adaptation..... | 99 |

Executive summary

This Deliverable provides an initial **overview of the common ICT toolkit architecture** that should be considered during the implementation steps in the WP7 activities. The results included in this document are the outputs of Task 7.1 “Design of the common ICT toolkit architecture” (M12-M18), in which the NEVERMORE consortium has developed the design of the overall ICT toolkit, including its architecture and the specification of each tool. Each tool can be considered as a service with specific functionalities according to the target user and the specific needs identified in during Task 2.5 activities “Identification of the socio-technological requirements”.

At the end, this document provides guidelines for the tools’ development. To do this, the authors have based themselves on their knowledge and previous experience in the development of tools, which has allowed them to have a design very similar to what could be the final product of the NEVERMORE project. However, it must be considered that it may be necessary to implement changes depending on the development needs and the required functionalities, but this must guarantee compliance with the functionalities provided for in the initial design of each tool.

Throughout the deliverable, the reader will find the design of the interfaces along with the explanation of their functionalities through use cases that establish the actions necessary to carry out a complete workflow in the application of each specific use case. The definition of the architecture made in this document will be the basis for correct sizing and development of the storage (Task 7.2 “NEVERMORE data storage”) as well as for both, frontend and backend development activities (Task 7.3 “Design and development of the different ICT solutions” and Task 7.4 “Development of the frontend for the different ICT solutions”) that will allow the user to have completely functional tools. The conclusions of the document will be relevant to define what the next steps will be in the implementation of NEVERMORE solutions and tools for raising awareness about climate change.

1. Introduction

The main objective of NEVERMORE is supporting the excellence in climate research and overcoming the current silo approach in evaluating climate change impact and risk across sectors and adaptation and mitigation solutions (AMS), also referred in other deliverables as policies and measurements (P&M). The project will develop an integrated common assessment framework consistent across scales for modelling, simulating and evaluating impact and risk as well as policy measures. The NEVERMORE assessment framework will be embedded in a practical and user-friendly ICT toolkit, including decision-making tools, designed and developed with and for the needs of the different stakeholders that are part of Local and Transnational Council of Stakeholders.

This deliverable is the outcome of Task 7.1 “Design of the common ICT toolkit architecture”. The aim of this task is to design the overall ICT toolkit, including its architecture and tools specifications based on the outcomes of Task 2.5 “Identification of the socio-technological requirements”. For this design, a software engineering process will be followed to ensure that all the expected requirements are fulfilled in an iterative and incremental process, although the future implementation of the tools will be based on an **Agile methodology**. Using this methodology, “Minimum Viable Products” will be available as soon as software modules and components (backend) and Graphical User Interfaces (GUIs) (frontend) are ready for a specific functionality of a tool as was specified in the users’ requirements and corresponding defined Use Cases.

Considering this point of view, the conceptual specification of the NEVERMORE ICT toolkit highly depends on the intended uses of each specific tool considering the target users and their specific needs, the use of scenarios and calculation methods, information workflows in the use of each tool, functional and non-functional requirements and finally, the Use Cases, preliminarily identified from the information collected in Task 2.5.

Starting from the **high-level architecture** proposed in the proposal stage, in which the most important parts of a monolithic architecture are covered (Data layer, Business Logic Layer and Application Layer), work has been done on the development of solutions or tools that can be integrated as different services that will make up the ICT toolkit of NEVERMORE. For each specific tool, the **functional and non-functional requirements** are provided and connected with the **Use Cases** giving deliverable readers information on functionalities of each specific tool (service). Each development is completed with images explaining the monolithic architecture for each service and potential technologies that will be helpful to start the implementation steps.

Finally, for the ICT toolkit (general access and tool manager) and each specific tool (Adaptation and Mitigation catalogue, Case Study tool, EU scale tool and Gamification tool), **mock-ups** are designed to represent how the functionalities of the toolkit will be presented to the user through interfaces that are aligned with the workflow defined by understanding the user needs. It is important to reflect that mock-ups are crucial in the development process due to they answer important visual questions and allow developers to plan and implement the coding activities. The final mock-ups will be created in Task 7.4 "Development of the frontend for the different ICT solutions".

1.1. Purpose of the document

The purpose of this document is to establish the basis for the development of the NEVERMORE ICT toolkit. To this end and as it is mentioned in the introduction, the main elements that are defined in this document are the following:

- Develop a methodology with the main steps that will be followed during the implementation to be able to have a set of functional tools by identifying and establishing a series of phases.
- Identify and evaluate the requirements for the tools coming from previous deliverables.
- Present the NEVERMORE ICT toolkit high-level architecture which defines the different layers of the toolkit, as well as the main components and modules, including the technical specifications and requirements that should be respected during the development.
- Define the functionalities, workflows and use cases for the ICT toolkit and each specific tool that will be part of it. Complementing the previous elements of the high-level architecture, monolithic architectures are defined covering the needs of each tool. This architecture will include the functional blocks covered, as well as how the different modules interact with each other including the IT definition of each step.
- Define the visual identity for the toolkit and each specific tool. Graphical User Interfaces are fundamental to ensure that all the functionalities are covered in an adequate and useful manner for the users. For this reason, preliminary mock-ups have been developed and presented to understand the components location, workflows and functionalities of each specific tool.

1.2. Structure of the document

The structure of the document goes as follows:

- **Section 1** (present section) introduces the document and its purpose.
- **Section 2** provides a glossary of technological terms in order to understand all the concepts provided in the document. This will ensure that the document is comprehensible for all readers also if they don't have programming skills.
- **Section 3** presents the methodology to build applications based on the main steps required for code implementation, deployment and validation. The methodology also includes some steps related with the design and conceptualization.
- **Section 4** shows the summary of the requirements identified in previous deliverables. These requirements are the starting point to create the ICT toolkit workflow and associated tools including also a first draft of the design by means of mock-ups.
- **Section 5** presents the high-level architecture of the NEVERMORE ICT toolkit including the main layers required for the implementation. In general terms, these layers are related with the Data Layer (databases), Business Logic Layer (communication) and Application Layer (visualization/interface). In addition, a section to present the synergies between the tools is included creating an understandable workflow of information between all the tools that are part of the toolkit.
- **Section 6** shows the main concept of the Adaptation & Mitigation (A&M) Catalogue Tool.
- **Section 7** shows the main concept of the Case Study tool.
- **Section 8** shows the main concept of the EU scale tool.
- **Section 9** shows the main concept of the Gamification tool.
- **Section 10** shows the main conclusion after the initial steps of the tools design and conceptualization. This section also includes some recommendation for the future activities that will be necessary in order to have functional tools.

2. Glossary of terms

This section includes the terminology utilized in the preparation of this deliverable with the objective of putting the reader in the proper context and terminology of the document, enabling them to understand all the concepts that were used to describe the initial steps of design and implementation of the NEVERMORE tools. These terms are included in Table 1.

Table 1. Glossary of terms.

| Term | Description |
|-----------------------------|--|
| Interface | A component facilitating communication and coordination between different nodes, such as layers, modules, or databases, within a system |
| Functional requirements | A specification defining the desired functionality or behaviour that a system, component, or process must exhibit. |
| Non-functional Requirements | A specification outlining the attributes, characteristics, or constraints that describe how a system should perform, rather than specifying specific behaviours. |
| Use Case | A detailed description of how a user interacts with a system, outlining specific scenarios and the expected outcomes. |
| Case Study | An in-depth analysis or examination of a particular subject, often involving real-world scenarios, to derive insights or understanding. |
| Actor | A user or entity interacting with a system, typically identified in use cases, influencing the system's behaviour. |
| Repository | A centralized storage location that holds and manages data, often organized for efficient retrieval and management within a system or application. |

3. Methodology for the design and development of the NEVERMORE ICT Toolkit

In software design, following a structured set of steps is crucial. These steps, known as the Software Development Life Cycle (SDLC), provide a necessary framework for creating software products. In the NEVERMORE project, a four-step methodology is followed: start-up, design, software development, and deployment phases. These stages offer a systematic approach, ensuring a smooth software development process.

3.1. Start-up phase

During this initial step, the project's feasibility is carefully examined. The primary activities in this phase involve understanding the business context and gathering requirements from the client's (end-user) perspective. Technical studies for this were initially conducted in D2.7 "Report on socio-technological requirements," and are set to be finalized in T7.1 "Design of the common ICT toolkit architecture." In the case of NEVERMORE and the ICT toolkit, citizens, researchers and policy-makers, are considered the main clients (end-users) of the software solution.

The outcomes of this phase encompass:

- **Description of the System:** This task aims to explain the system's behaviour in a language understandable to the client, devoid of technical jargon. The documentation was included in D2.7, outlining recommendations and required functionalities, reflecting the needs of the end-users.
- **Requirements:** A comprehensive list of conditions that the system must fulfil is compiled based on the end-user's needs. This compilation covers both functional and non-functional requirements, including aspects like performance and security. While an initial list was presented in D2.7, this document provides detailed information within this context.
- **Interfaces:** This step involves the preliminary design of interfaces essential for communication between entities and between the system and end-users. These interfaces encompass external entities like databases and graphical user interfaces.
- **Glossary:** All terminology agreed upon between the client and developer is gathered to ensure mutual understanding and clear communication.

3.2. Design

During this phase, the intricate workings of the software application are planned. Several critical aspects come under study, including the overall architecture, user interface, compatible platforms, chosen programming methods, communication protocols, and security measures. Each of these elements is carefully considered to ensure seamless functionality and user experience.

In this phase, the following documentation is generated:

- **Use Cases and Use Cases Diagrams:** The first draft of the use cases outlines the main actors and primary operations. Building upon this first step, a detailed version is elaborated on each use case, including behaviours and exceptions. This document provides a comprehensive understanding of each use case.
- **Architecture:** This document captures the business concepts' performance, providing an overview without delving into software methods or classes. In the NEVERMORE project, the architecture was divided into functional blocks, modules, and components, initially defined in the Grant Agreement (GA).

3.3. Implementation phase

This phase is commonly referred to as the programming or coding stage. The program's code can be written by either an individual developer or a team of developers working collaboratively. Within the coding process, various tasks are incorporated, including identifying and rectifying errors and glitches, as well as testing and compiling the code to ensure the application runs smoothly.

An Agile methodology is set to guide the development process, enabling automation to focus on individual functionalities. To achieve this, dedicated sets of repositories for data models, backend APIs, and frontends for graphical user interfaces (GUIs) will be concurrently developed for each specific functionality planned for the platform. This approach allows for the creation of a functional platform at an early stage, ensuring that end-users can engage in consultations effectively. The code may also contain instructions and explanations to assist developers, simplifying the development tasks. Additionally, this stage encompasses the creation of user guides to aid end-users in navigating the application.

3.4. Deployment phase

In this consolidated phase, both testing and maintenance activities play vital roles in ensuring a smooth user experience and ongoing application functionality.

Testing in the agile development process is an iterative and continuous endeavour aimed at minimizing bugs and glitches, while simultaneously enhancing user satisfaction and boosting usage rates. This iterative approach ensures that issues are identified and rectified promptly, contributing to the development of a robust and user-friendly product. Following each iteration of thorough testing, the application is deployed incrementally, allowing users to access and interact with evolving features.

Continuous user feedback is incorporated, allowing developers to resolve issues and enhance the application's functionality.

4. Summary of requirements identified in previous deliverables

In this section, the requirements identified from the surveys conducted in Task 2.5 (and reported in D2.7) are summarized and reported in table form. The four tables below highlight the most relevant user needs from each case study and expert perspectives. The needs are reported as tool functionalities and they are characterized based on the tool (A&M Catalogue tool, EU-scale tool, Case Study tool and Gamification tool), on the opinion of case study or experts and the specific case study which desires that functionality. In Table 2, a legend is displayed which allows to understand of a functionality is going to be addressed, partially addressed or not addressed.

Table 2. Legend for displaying the three different levels of addressing the requirements.

| | |
|----|---------------------|
| ✓ | Totally addressed |
| // | Partially addressed |
| X | Not addressed |

Table 3. Requirements from case studies and experts for the A&M Catalogue Tool.

| Case Study | Desired functionalities for A&M Catalogue tool from case studies perspective | |
|-----------------------------|--|---|
| CS1 - Sitia | To include just the most significant policies so that it is not overwhelming for the users | ✓ |
| CS1 - Sitia CS4 - Murcia | To show the catalogue in the different local languages | ✓ |

| | | |
|--|--|----|
| CS1 - Sitia | To show policies on emergency management (in particular of fires, flood and other natural hazard since Sitia is really affected by them) to provide easy and clear information to local citizens and tourists on how to deal with them | // |
| CS2 - Trentino | To provide best practices exchange by inspiring decision makers to learn new solutions from different experiences to common issues | ✓ |
| | To support the participatory processes of policy design and development to overcome the difficulties of some local administration to develop shared territorial policies | ✓ |
| | To comprise an evaluation of policies' effectiveness (by using indicators like temperature variations or CO2 emission) | // |
| | To include recommendation on how to implement, incentivize and adapt policies to a specific territory | X |
| | To allow the users to go through the information in the catalogue with different granularities based on their needs | ✓ |
| CS2 - Trentino CS4 - Murcia | To provide a connection between the catalogue and the local/global tool, so that when the user clicks a policy it would be possible to see the impacts with an interactive tool | ✓ |
| | To allow the immediate search in the catalogue through key words and filters (e.g. filter the policies based on geographical and climatic characteristics of users' areas of interest) | ✓ |
| CS3 - Norrbotten | To evaluate policies based on their success so that municipalities could be persuaded in implementing them | ✓ |
| | To allow the visualization of combinations of policies and their effects to evaluate the synergies and trade-offs | ✓ |
| | To provide the relevance of the policies in a specific area by comparing it with similar municipalities (based on municipality size and geographical similarities) | ✓ |
| CS4 - Murcia | To show the catalogue in an easy to use way without technical jargon | ✓ |
| | To allow the access to directly actionable information to act sooner without spending long times reading documents (e.g. accessing SECAPs from neighboring municipalities) | // |
| CS5 - Tulcea | To display an interdisciplinary perspective on policies that goes beyond sectors | ✓ |

| | | |
|---------------|--|---|
| | To show an overview of policies at different scales and their synergies and trade-offs | ✓ |
| Expert | Desired functionalities for A&M catalogue tool from expert perspective | |
| CMCC | To display cross-sectoral measures and the synergies and trade-offs between them | ✓ |
| | To provide both local and global scale dimensions | ✓ |
| | To provide measures quantification and the outcomes of policy simulation to visualize the impact of a specific measure | X |
| | To connect the challenges experienced by the five case study territories related to specific policies and solutions | ✓ |
| | To support the user in the navigation of a large amount of policies (e.g., being able to filter information) | ✓ |

In A&M Catalogue tool (Table 3), the catalogue will be displayed in a comprehensible and not overwhelming way by comprising just the most relevant policies, avoiding too technical words and allowing the change of language to the one desired by the user. Moreover, the implementation of filters and keywords for a quicker search through the policies is a feature that it is appreciated by the experts and also by the case studies which value also the possibility of digging into the catalogue with different granularities based on the users' needs. The catalogue will not only provide policies at both local and global scale dimensions, but also will allow to combine them to evaluate their synergies and trade-offs. The recommendations on how to implement policies in a specific case study will be object of the Case Study tool being the catalogue a tool running with the other two assessment tools to provide these policy analyses.

Table 4. Requirements from case studies and experts for the EU-scale Tool.

| | | |
|-----------------------|--|----|
| | Desired functionalities for EU-scale tool from case studies perspective | |
| CS1 - Sitia | To allow the display of several graphs for each indicator to visualize the results and make them clearer for the users | ✓ |
| | To show comparisons between the results of global/local models to see how the models are representing reality | X |
| CS2 - Trentino | To comprise sectors that are relevant for the case studies (e.g. Tourism) | ✓ |
| | To show the model reliability and transparency of the assumptions made in the models and information regarding the temporal dimension of a policy impact | X |
| | To provide not just a decision-making tool but also an interactive modelling tool to increase the support on sustainability policies of citizens | ✓ |
| | To allow flexibility and adaptability to unforeseen circumstances related to the unpredictability and the complexity of policy-making | // |

| | | |
|--------------------------------------|--|----|
| | To connect the catalogue to the modelling tool to see the impacts of the measures implemented | // |
| | To compare different policies based on impacts and costs | ✓ |
| CS3 - Norrbotten | To provide always the Business as Usual (BaU) approach in the graphs to see the improvements or worsening of the effects with respect to the situation without the policies (baseline) | ✓ |
| | To see the effect of combinations of policies | ✓ |
| | To allow the visualization of the changes in the graphs without delays reducing the simulation needs | // |
| | To provide clarity through graphs with simple titles and legends | ✓ |
| CS4 - Murcia CS5 - Tulcea | To allow the possibility of changing the tool language to make it more comprehensible to the citizens | // |
| CS4 - Murcia CS5 - Tulcea | To provide also an easy to use and not too sophisticated tool that can be used also by non-specialists so that they can easily familiarize with models and simulations | ✓ |
| CS5 - Tulcea | To show the details of the policies (e.g. start date - end date) and the effects in the implementation timeline | ✓ |
| Expert | Desired functionalities for EU-scale tool from expert perspective | |
| CARTIF | To show precompiled data in the web interface so that the interface would be responsive and the users could interact in real time with it | ✓ |
| | To save configurations from one session to another by creating an account so that users can save the developed scenarios | ✓ |
| | To explain and provide module assumptions and details of policies in order to ensure transparency | ✓ |
| | To show results not only at EU-level but also at regional level (WILIAM regional disaggregation) so that it would be possible to see the impact of global policies on other areas | ✓ |
| | To use system dynamic models | ✓ |
| | To show results without using maps (but graphs) | ✓ |
| | To create a scenario just by switching on the already available policies | ✓ |
| | To allow the exploration of just one indicator at the time to prevent confusion | ✓ |
| | To compare the BAU scenario with the chosen one and download the results (CSV file) | ✓ |
| | To save, make public and rate scenarios for registered users to visualize which one is better by making the tool more participatory (possibility also to win a context) | ✓ |

| | | |
|--|--|----|
| | To show the costs of the policies to identify the financial feasibility in the implementation of the policy | ✓ |
| | To run the model in real-time in the browser (port the model to Web Assembly) to produce the results in milliseconds | ✓ |
| | To allow the user to select different travel modes, ways of living in the houses, or diet or consumption | // |

The EU-scale tool (Table 4) will be easy to use and comprehensible for not-specialists by allowing to change the language and not using too technical jargon. This is considered a relevant feature by the case studies that also value the representation of the results through clear graphs allowing the comparison between outcomes with and without policy implementation and the visualization of the impacts in a very simple way. In order to facilitate the user’s engagement with the interface, the tool will show precompiled data to allow the interaction in real time with the interface and will allow the user to save developed scenarios and compare them with scenarios of other users.

Table 5. Requirements from case studies and experts for the Case Study Tool.

| Case Study | Desired functionalities for Case Study Tool from case studies perspective | |
|--|--|----|
| CS1 - Sitia | To show useful and clear results to help defining present and future decision-making practices | ✓ |
| | To show in a tangible way (e.g. graphs) the outcomes from the simulation of policies | // |
| | To integrate results (e.g. cost-benefit) that can show how individual choices impact society | ✓ |
| CS2 - Trentino | To show the impact at local level of a global policy | // |
| CS2 - Trentino CS5 - Tulcea | To adapt based on territorial/local specificities and vulnerabilities | ✓ |
| CS2 - Trentino | To clearly express the level of reliability and robustness of the used models | ✓ |
| CS3 - Norrbotten | To know what the scenario will be if a particular measure is taken | ✓ |
| | To show data related with each city | X |
| CS3 - Norrbotten CS4 - Murcia CS5 - Tulcea | To be appealing to the user and easy-to-use / straightforward, not use of complex or too technical language | ✓ |
| CS4 - Murcia | To support and display Sustainable Energy and Climate Action Plans (SECAPs), SECAPs possible effects and the reasons why specific actions were included | // |
| | To provide the use of the local language | ✓ |
| | To show how temperature and other specific indicators (CO ₂ emission and precipitation) change based on future scenarios and policies application | ✓ |
| | To show both adaptation and mitigation policies (not just mitigation) | ✓ |

| | | |
|---------------------|--|----|
| | To track the evolution of the participatory process by making the tool more interactive (e.g. possibility to compare scenarios with other people registered) | // |
| CS5 - Tulcea | To influence people in changing their attitude and behavior about climate change through for example cost benefit analysis of measures and also by making it accessible to communication specialists | ✓ |
| | To integrate EU and local scale tool | ✓ |
| Expert | Desired functionalities for <u>Case Study Tool</u> from expert perspective | |
| RINA-C | To provide an integration and communication between the model at global and at local level used in case-study tool | ✓ |
| | To show a visual design based on the user needs in order to identify the degree of complexity and the kind of choice to give to the user according to the user expertise | ✓ |
| | To allow continuous data updates by certified users by providing different rights to access to the tool | X |
| | To allow users to select variables that inform an asset's fragility to a specific hazard: - Geographic area/region - Sectors affected - Type of asset - Asset attributes - Socio-economic indicators - Type of hazards | ✓ |
| | To show the relationship between data through graphs or other visualizations | ✓ |
| | To provide maps showing hazard and assets | ✓ |
| | To guarantee the integration between back-end and front-end development in the tool | ✓ |

The Case Study tool (Table 5), such as EU-scale tool, will provide a straightforward and easy to use interface thanks to the implementation of not too complex jargon and the possibility of selecting the local language. This together with the adaptability of the tool to local characteristics are considered particularly relevant features by the case studies' stakeholders, which appreciate the tangibility of the results to help the definition of future decision-making practices. Regarding the models, there will be an integration of the local and global levels, and transparency with respect of the models' reliability. In the Case Study tool, the outcomes from the simulation of policies will be included if the methodology/model applied at case study level is prepared for this type of assessments.

Table 6. Requirements from case studies and experts for the Gamification Tool.

| Case Study | Desired functionalities for <u>Gamification tool</u> from case studies perspective | |
|--|---|---|
| CS1 - Sitia CS2 - Trentino CS3 - Norrbotten | To raise awareness and educate general population (not professionals in the sector), in particular kids and young generations, by encouraging the interest in the climate | ✓ |

| | | |
|--|---|----|
| | change topic such as resource management and incentivizing tourists to sustainable behavior | |
| CS1 - Sitia | To allow the inclusion of a local dimension | ✓ |
| CS2 - Trentino CS3 - Norrbotten | To encourage change in consumption behavior by sharing data such as water and energy consumption in a more playful and clear way which could justify sustainable behaviors (e.g. limited shower time) | // |
| CS4 - Murcia | To allow the use of the native language | X |
| | To provide a very easy to use and fun tool for the younger people to learn on climate change | ✓ |
| | To influence kids and consequently parents who can put pressure on the political representatives of their areas to act on climate change | ✓ |
| CS5 - Tulcea | To provide a simplification of the variables involved in climate change | // |
| | To provide also a gamification app which could be used offline for areas without good internet connection | // |
| Expert | Desired functionalities for Gamification tool from expert perspective | |
| CARTIF | To educate on the relationship between economic growth and sustainability, role of technology etc. | ✓ |
| | To include flexibility in the game to permit the players to modify their choices during the simulation | X |
| | To provide social aspects in the game (e.g. well-being and inequality) | ✓ |
| | To allow an easier accessibility to the gamification tool (e.g. a mobile phone version) | ✓ |
| | To provide a localized version of the game (by downscaling environmental impacts, socio-economic implications and potential solutions) so that the people could relate more to the issues | ✓ |

The Gamification tool (Table 6) will be able to educate in a playful and fun way the younger generations and the general population to climate change topics, and therefore, raise awareness on the implementation of sustainable behaviours. Moreover, having a localized version of the game will make it more relatable to the people that will also have the possibility of choosing the language. Other important features of the game are its flexibility, because it allows the users to modify their choices while the simulation is running, and its accessibility, by providing a mobile phone version. The introduction of the social dimension in the game was also encouraged to increase the engagement of the users by including characteristics such as well-being and inequality.

5. High-level architecture

This section introduces a high-level architectural (Figure 1) scheme designed to meet the analysed requirements and functionalities for the ICT toolkit. The architecture is structured as a three-layer system, clearly delineating between the application layer, business logic layer, and data layer. Each

layer is meticulously defined, and specific communication interfaces have been established to facilitate seamless interactions between these layers.

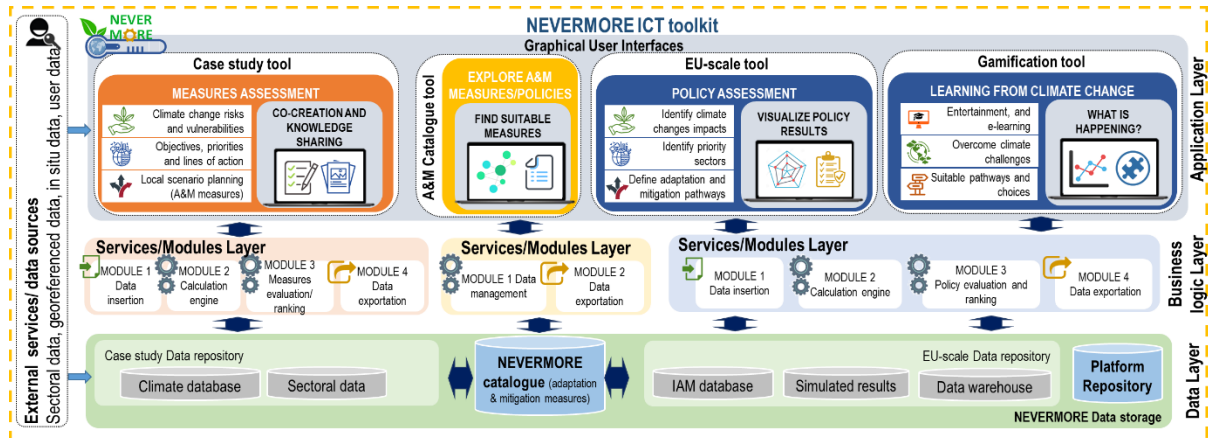


Figure 1. NEVERMORE high-level architecture.

- **Application Layer:** This layer serves as the primary interaction point between the tool and the end user, primarily handling tasks related to data inputs, outputs, and result visualizations. In addition to these functions, it also accommodates other interactions such as data modifications and service status checks.
- **Business Logic Layer:** The business logic layer functions as the core engine of the system, orchestrating complex operations and processing data received from the user interface layer. It encapsulates the algorithms, calculations, and decision-making processes vital for the tool's functionality.
- **Data Layer:** The data layer serves as the repository for all information essential to the tool. It encompasses databases, storage systems, and other data structures where raw data, configurations, and processed information are stored securely. This layer facilitates efficient data retrieval, storage, and manipulation, ensuring seamless access for business logic layers.

Nevertheless, the approach includes developing individualized architectures for each tool, emphasizing flexibility, modularity, and scalability. Each tool will boast its unique user interface, following project guidelines and stylistic elements. Furthermore, independent service modules and dedicated databases will be designated for each tool, fostering simplicity, scalability, and streamlined development processes. Despite this independence, each layer and block will have its corresponding interface, ensuring seamless interoperability and integration across all tools. This strategic balance between individuality and interoperability assures the way for a robust, adaptable, and cohesive toolkit ecosystem.

5.1. Description of architecture layers and components

This section offers an in-depth and comprehensive description of each layer, encompassing the data layer (5.1.1), business logic layer (5.1.2) and application layer (5.1.3). The description provides insights into the components that constitute each layer, offering an understanding of their respective functionalities and interactions within the overall architecture.

5.1.1. Data layer

The data layer serves as the central storage hub for NEVERMORE project data. It adopts a tool-divided architecture, featuring distinct and independent data repositories for each tool. Within this layer, there exist specific repositories, including the Case Study Data Repository, EU-scale Data Repository, Gamification Tool Data Repository, and Catalogue Data Repository. While the first three repositories maintain individual functionalities, they establish communication with the Catalogue Repository. This

interconnectivity ensures access from these tools to the Catalogue and fosters synergies and trade-offs between the various tools, enhancing the overall coherence of the NEVERMORE project data storage.

- **Case Study Data Repository:** Functions as the central data hub for the Case Study Tool. It comprises two distinct databases: i) The Climate Database and ii) the Sectoral Data Database. These databases collectively house and manage the essential data required for the Case Study Tool.
- **EU-scale Data Repository & Gamification Repository:** Both repositories are independent but present the same structure. Those repositories are composed of three integral databases: the IAM Database, the Simulated Results Database, and the Data Warehouse. The Simulated Results Database plays a crucial role in optimizing the tool's performance by storing pre-calculated values for frequently executed client actions. This database is designed to handle substantial volumes of data efficiently, ensuring swift data retrieval. Additionally, a Data Warehouse database is employed to store user information and other data generated throughout the tool's usage. IAM Database is used to store the simulation model and related data.
- **A&M Catalogue Database:** it is comprised of a single relational database dedicated to storing information about various adaptation and mitigation solutions. This database serves as the centralized repository for data related to different strategies and measures within the A&M Catalogue tool.

5.1.2. Business Logic Layer

The Business Logic Layer assumes a central role within the architecture, responsible for implementing the platform's core functionalities. These functionalities encompass coordinating the retrieval and storage of data, implementing the backend processes, facilitating communication between different tools, and overseeing interactions with the application layer. Each tool maintains its distinct business layer, incorporating some of the four predefined modules to execute logic operations effectively.

- **Data insertion module:** It specializes in handling the addition of new data into the system. Its primary function is to manage and streamline the process of inserting fresh data, ensuring that it is accurately captured, validated, and stored in the appropriate repositories. Its key features are: data validation, data transformation, error handling, database interaction, security implementation.
- **Data exportation module:** Involves retrieving data from databases to be utilized by users and other components within the business layer. Key aspects related to data retrieval within the data exportation module include:
 - *Database Querying:* The module is equipped to execute queries on the databases, retrieving specific datasets based on user requests or system requirements.
 - *Optimized Retrieval:* It focuses on optimizing data retrieval to ensure quick access to the required information.
 - *Data Transformation:* The module may involve transforming the retrieved data into a format that is suitable for export or for further processing within the platform.
- **Calculation engine module:** Responsible for executing complex calculations, algorithms, and logical operations essential to the functionalities of the platform. This module is designed to handle computations, data analyses, and generate valuable insights based on the input data. Key characteristics of the calculation engine module include: algorithm execution, data processing, dynamic logic operations execution, parallel processing and real-time calculation.

- **Evaluation and ranking module:** It serve as a specialized component within both the Case Study Tool and EU Scale Tool. Tailored to the unique needs of these tools, this module extends the capabilities of a standard calculation engine to perform intricate logical operations specifically focused on evaluating and ranking measures within different scenarios.

5.1.3. Application Layer

The Application Layer stands as the outermost layer in the architecture, serving as the user-facing interface and facilitating interaction with the NEVERMORE ICT Toolkit functionalities. Notably, each tool maintains its distinct application layer, ensuring a customized and tailored user experience.

The application layer plays a crucial role in not only facilitating data insertion but, more importantly, in presenting and visualizing results across various tools and functionalities through graphical user interfaces. For a more comprehensive understanding of the application layer, it is advisable to refer to the "Mock-ups" section provided within each tool's documentation. This section offers visual representations and prototypes that illustrate how the application layer is designed to present and interact with the results, features, and functionalities specific to each tool. In addition to the individual application layers for each tool, a common application layer is introduced to oversee user access, user logs, and user accounts across the entire platform. This common layer enhances the overall platform administration and ensures a unified approach to user management.

From Figure 2 to Figure 5, mock-ups for the common application layer are presented. This layer serves as a central hub for all tools, offering access to each tool from a unified interface. The goal is to create a user-friendly experience, ensuring coherence across the platform while enabling convenient user account and private data management. The common application layer acts as a nexus, streamlining user interactions and providing a seamless gateway to all tools from a single location. The interfaces represented in the mock-ups are connected with the use cases (UC) included in Table 7.

Table 7. Use Cases and description for the general toolkit. Detailed information: Section 13.1.

| Use case number | Use case name | Description |
|-----------------|-----------------------|---|
| UC1 | Register as tool user | The user is able to register as tool user |
| UC2 | Log into the tool | The user is able to login as tool user |
| UC3 | Recover password | The user is able to recover the password for an account |
| UC4 | Tool selection | The user is able to select the tool before starting an analysis |

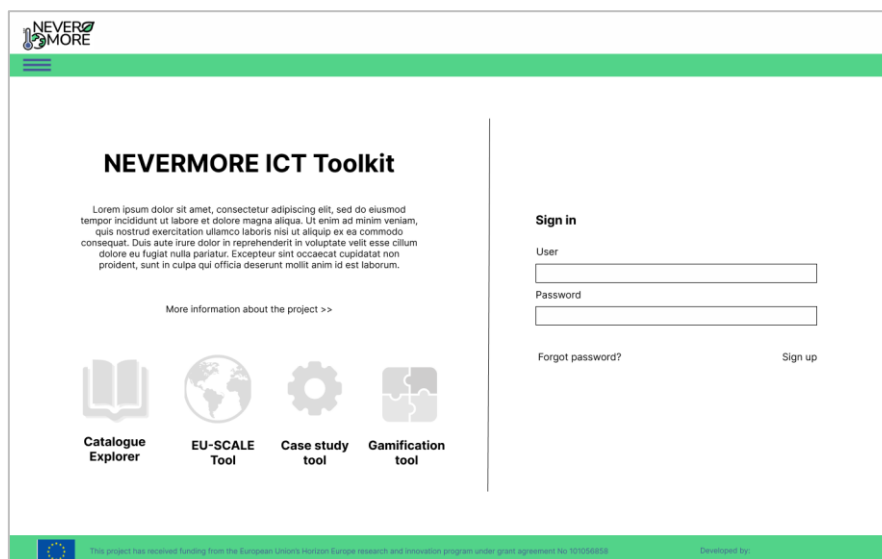


Figure 2. Main page of the NEVERMORE ICT toolkit including the login, register and information on the tools.

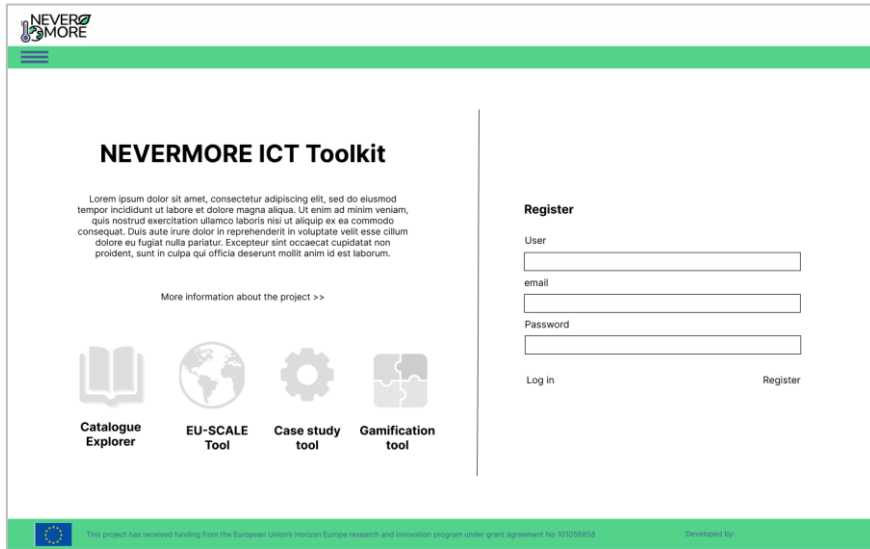


Figure 3. Main page of the NEVERMORE ICT toolkit with the register form.

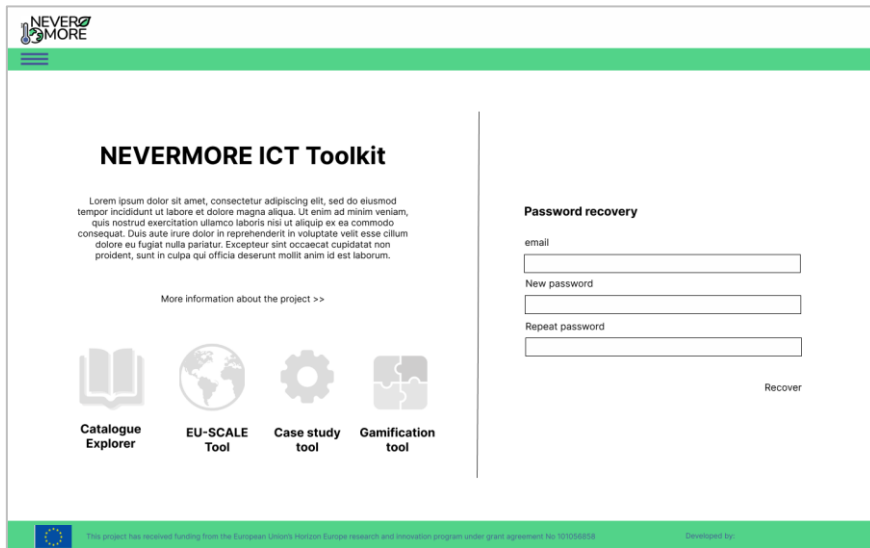


Figure 4. Main page of the NEVERMORE ICT toolkit with the password recovery form.

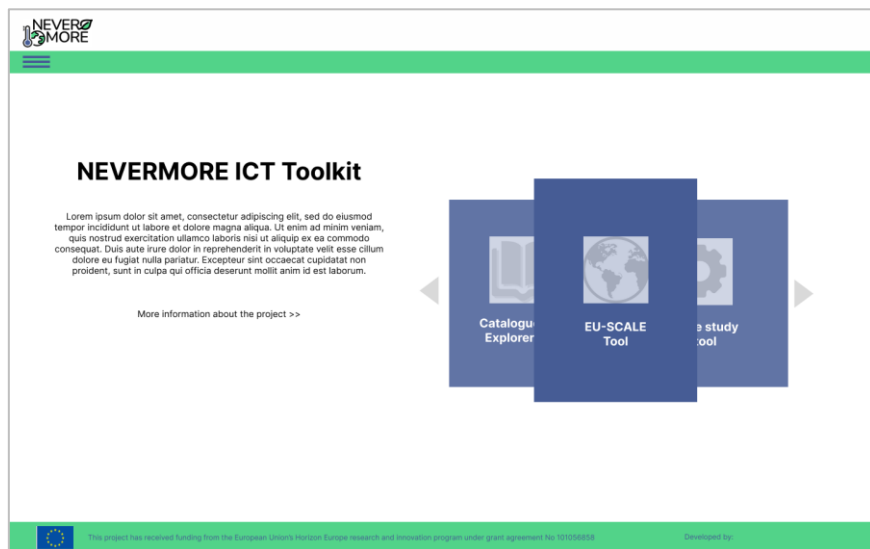


Figure 5. Interface for tool selection.

5.2. Interfaces identification

The provided diagram (Figure 6) illustrates the interfaces identified in accordance with the proposed architecture outlined in this document. An interface is defined as a component responsible for communicating and coordinating between two nodes, where these nodes can represent different layers, modules, or databases. Within this architecture, a total of 14 interfaces have been identified.

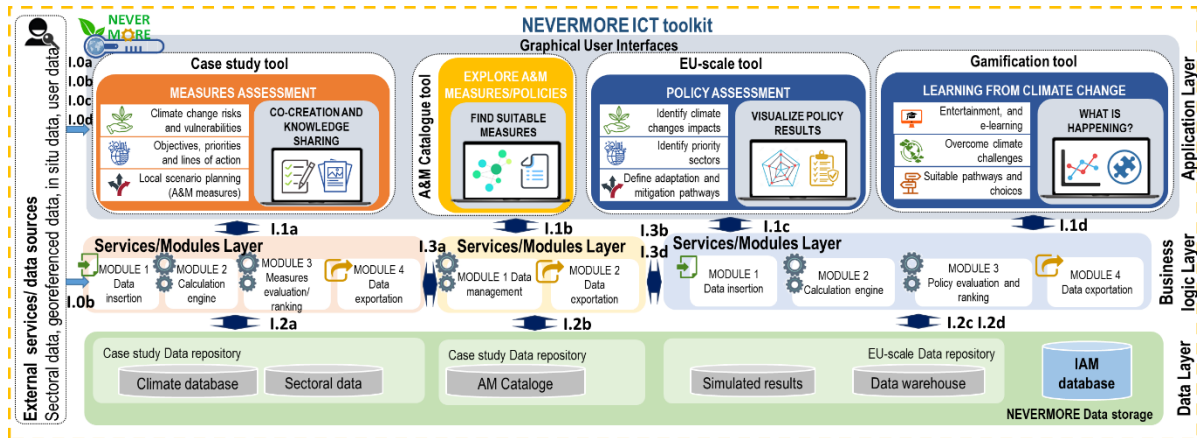


Figure 6. NEVERMORE high-level architecture with the identification of the different interfaces.

- **Interfaces I.0** encompass the most external communications, enabling the platform to receive data from end-users or external databases and resources. **Interfaces from I.0a to I.0d** facilitate the input of external data into each application layer of the respective tools (I.0a for the Case Study Tool, I.0b for the A&M Catalogue Tool, I.0c for the EU Scale Tool and I.0d for the Gamification tool).
- **Interfaces I.1** manage communication between the application layer and the business logic layer, with specific interfaces (**I.1a to I.1d**) designated for each tool. Specifically connects each GUI with the modules inside each business logic layer. Modules in the business logic layer are fed by data retrieve from users at GUI level.
- Similar to the I.1 interfaces, a family of **I.2 interfaces (I.2a to I.2d)** facilitates communication between the business logic layer and the data layer for each tool. These interfaces allow for implementing strategies for streamlined and optimized data retrieval processes.
- Lastly, a family of **I.3 interfaces** is introduced, aiming to connect each tool with the Catalogue Tool. These interfaces foster interoperability, synergies, and trade-offs between tools within the ICT.

5.3. Performance, security and manageability

In this section, an analysis of the performance, security and manageability aspects of the NEVERMORE ICT toolkit is presented.

5.3.1. Performance

In order to estimate the performance of the NEVERMORE ICT toolkit, three major indicators are used:

- **Workload.** It refers to the maximum capacity of each tool to handle processes and concurrent tasks.
- **Response time.** This is the length of the time that a system needs to react to a given event. The response time has to be perceived for the user as (near) real-time, as far as possible. It is necessary to reflect that in the simulation steps using system dynamics models, the calculation time could be large, being necessary to provide alternative methods as emulated data or simplified models.

- **Scalability.** It refers to the system's ability to process the increasing workload (or even functionalities), data or multiple users at the same time without having errors.

5.3.2. Security

The security component focuses on regulating data access, preventing potential harm to hardware and software, and ensuring protection against service disruptions. Given the web-based nature of the system, the primary emphasis within the security infrastructure will be on implementing HyperText Transport Protocol Secure (HTTPS). Safeguarding application security involves three fundamental approaches: examining and scrutinizing code and applications, conducting manual penetration testing, and incorporating a web application firewall. Given the diverse actors on the toolkit and their specific access permissions, the implementation of a role-based authorization system is essential to define and enforce accessibility constraints. User registration and login are mandatory for accessing specific functionalities, using the application of accounting to record users' access activities. An effective security strategy for cloud-based systems involves the application of Authentication, Authorization, and Accounting methods (AAA). Authentication is a verification process where provided credentials are compared with those stored in a database of authorized users, either locally or on an authentication server.

5.3.3. Manageability

Manageability involves the operational functionality of a system, encompassing the software's capability to be overseen from various viewpoints. It delineates four distinct perspectives: operational, monitoring, integration, and information manageability.

- **Monitoring manageability:** involves the continuous real-time monitoring of key aspects within the system, allowing for critical management through the monitoring interface.
- **Operational manageability:** system's manageability from an operational standpoint.
- **Information manageability:** involves ensuring that the system can efficiently process, organize, and maintain information, particularly when dealing with varied types of data, formats, and sources.
- **Integration manageability:** the system's ability to seamlessly integrate with third-party systems.

5.4. Synergies and Trade-offs between tools

Synergies and trade-offs between the four tools refer to the interconnected relationships and strategic balances established among the tools within the platform. Synergies involve the collaborative and mutually beneficial interactions between tools.

The primary synergies emerge between the Case Study Tool and the EU Scale Tool with the Catalogue Tool. The Case Study Tool explores measures at local and regional scales, and the EU Scale Tool examines policies at the global/EU level, both being interconnected with the corresponding adaptation and mitigation solutions in the Catalogue Tool. The A&M Catalogue Tool serves as a nexus between tools, providing users with a comprehensive understanding of their specific case study. Additionally, the Gamification Tool plays a role by allowing users to learn about measures that can be later tested in the models of the Case Study Tool and EU Scale Tool, fostering a dynamic and interconnected approach to the platform functionalities.

The second synergy is related with the data used to obtain results in each tool. Both, the EU Scale tool and the Gamification tool are based in pre-simulated results of WILIAM model at least to evaluate the mitigation aspects. In this sense, the "simulated results database" will be crucial to obtain accurate results in both tools with a good time response and an efficient workflow in the use of information. Finally, one of the most critical synergies, is related with the interaction of information between the

Case Study tool and the EU Scale tool. To this end, a clear and comprehensible methodology will be developed in order to align the modelling results between scales.

6. A&M Catalogue Tool

6.1. Introduction

The Adaptation and Mitigation Solutions Catalogue Tool (A&M Catalogue) is an integral component of the NEVERMORE ICT toolkit. This user-friendly tool aligns with the core principles of the ICT toolkit, aiming to empower users in understanding the intricate interplay between climate change and adaptation and mitigation policies through a user-friendly and interactive interface.

The tool is designed to provide a catalogue of solutions related to climate change mitigation and adaptation (AMS). It encompasses a review of cross-sectoral measures that have already been put into action, potential solutions identified through literature research, and scenarios collaboratively developed with local councils and stakeholders.

With its graphical tools and data visualization capabilities, users can easily select and view relevant data, factsheets, and key insights for each measure or policy. The tool enables users to assess synergies, co-benefits, and trade-offs between different measures, as well as their multi-sectoral effects. The tool aims to assist users in finding the most suitable adaptation and mitigation strategies at local, regional, EU, and global scales.

The A&M Catalogue is specifically tailored for particular user groups, with each group's intended audience and their specific usage scenarios detailed below:

- **Policy-maker:** Easily evaluate and compare adaptation and mitigation measures from a cross-sectoral catalogue. Compare in an efficient way the economic costs and the adaptation and mitigation potential between measures.
- **Researcher:** Access a comprehensive database of measures and policies, including existing implementations and literature research, to analyse their co-benefits, synergies, and trade-offs for their climate change studies and investigations.
- **Citizen:** Understand the available adaptation and mitigation measures and their potential co-benefits and trade-offs. Contribute to climate action efforts in their community and make informed choices in their daily life.

From previous deliverables (D2.7 “Report on socio-technological requirements”) a possible fourth target group has been identified:

- **Tourist:** Quickly access information and guidelines on how to act during emergencies or natural disasters in the visited area, so safety can be ensured and appropriate actions taken.

6.2. Requirements

In this section, we will outline a comprehensive list of both functional and non-functional requirements for the tool. Additionally, we will develop specific use cases within the tool, providing practical scenarios for its application. Furthermore, we will introduce a preliminary version of the tool's interface mock-ups, offering a visual representation of its design. Finally, key aspects related to the tool's architecture will be discussed, providing insights into its structural framework.

Requirements serve as both a description and specification of the desired system functionality, encompassing not only the system's actions but also its performance attributes. In this section, we present the initial version of these requirements, which are categorized into two main groups: functional requirements and non-functional requirements.

6.2.1. Functional requirements

Functional requirements have been derived from a thorough understanding of end user needs, various usage scenarios, and the specific actions required from both the Catalogue Tool and the ICT Toolkit platform. Below is an initial version of these requirements, presented in Table 8.

Table 8. Summary of the functional requirements for the NEVERMORE A&M Catalogue tool.

| Use case name | | Req. ID | Functional Requirement description |
|-------------------------|----------|---------|---|
| Search A&M Solutions | Any user | FR 1 | The system should allow to search specific terms overviewing all matching A&M solutions |
| Submit Solutions | Any user | FR 2 | The system should allow users to submit their own adaptation and mitigation solutions, sharing their experiences and successes for others to learn from. |
| Navigate to Global Tool | Any user | FR 3.1 | The system should establish connections and integration between the catalogue of measures and the global tool, enabling seamless access to related information and resources. |
| Navigate to Local Tool | Any user | FR 3.2 | The system should establish connections and integration between the catalogue of solutions and the local tool, enabling seamless access to related information and resources. |
| Select A&M Solution | Any user | FR 4.1 | The system should allow users to assess and consider the scale dimension of each adaptation and mitigation solution, helping them understand its applicability and effectiveness at various levels. |
| | | FR 4.2 | The system should display the type of policy , either adaptation or mitigation, associated with each solution. |
| | | FR 4.3 | The system should display the sectors associated with each measure. |
| | | FR 4.4 | The system should display the location (including climate and population density, if relevant) associated with each measure. |
| | | FR 4.5 | The system should display the scale associated with each measure. |
| | | FR 4.6 | The system should display information about how each measure can be financed, helping users understand the financial aspects and considerations associated with their implementation |
| | | FR 4.7 | The system should display the success of each measure in other geographical areas, showcasing its applicability and potential benefits. |
| | | FR 4.8 | The system should display the effectiveness of policies associated with each measure, highlighting their impact and outcomes. |
| | | FR 4.9 | The system should connect each measure to general challenges to policies and solutions, providing users with a holistic understanding of the context and potential hurdles. |
| | | FR 4.10 | The system should provide analytical tools or visualizations that enable users to analyse and evaluate the synergies and trade-offs with other measures or policies when a specific measure is selected. |
| | | FR 4.11 | The system should include information and recommendations about how policies can be |

| | | | |
|--------------------------------|----------|--------|--|
| | | | implemented and adapted to specific territorial areas, providing guidance for users. |
| Download Factsheet | Any user | FR 5 | The system should provide the option for users to download a factsheet or summary document for each policy, offering a concise and printable resource. |
| Select Multiple AMS | Any user | FR 6 | The system should allow users to analyse and assess the synergies, trade-offs, and potential impacts that can arise from selecting multiple policies or measures. |
| Geographic Filtering | Any user | FR 7.1 | The system should enable users to filter and search for policies based on geographical and climatic areas of application, ensuring relevance and suitability. |
| Implemented Solution Filtering | Any user | FR 7.2 | The system should provide the option to filter by policies that have already been implemented in specific areas, allowing users to learn from successful practices. |
| Multiple filtering | Any user | FR 7.3 | The system should allow users to apply multiple filters simultaneously , enabling them to refine their search and analysis based on various criteria. |

6.2.2. Non-functional requirements

These requirements are not focus on the functional operations of the platform. Instead, they focus on ancillary aspects, particularly concerning the platform's performance and security. Below is an initial version of these requirements, presented in Table 9.

Table 9. Summary of the non-functional requirements for the NEVERMORE A&M Catalogue tool.

| Req. ID | Functional Requirement description |
|---------|---|
| NFR 1 | The system should provide a user-friendly interface with easy navigation to ensure a smooth user experience |
| NFR 2 | The system should have an interface that can effectively display and handle a large number of policies, ensuring accessibility and ease of use. |
| NFR 3 | The system should be responsive and provide quick access to information, minimizing loading times and delays in displaying data or results. |
| NFR 4 | The system should support multiple languages, allowing users to access information and navigate the tool in their preferred language. |
| NFR 5 | The system should implement appropriate security measures to protect user data, ensuring confidentiality, integrity, and availability. |
| NFR 6 | The system should be designed with accessibility standards in mind, making it accessible to users with disabilities and complying with relevant accessibility guidelines |
| NFR 7 | The system should comply with data protection regulations and respect user privacy, implementing measures to secure and safeguard personal information. |
| NFR 8 | The system should be well-documented, providing clear instructions, guidelines, and user manuals for users and administrators. |
| NFR 9 | The system should include high-level cross-sectoral policies to provide a comprehensive view of climate adaptation and mitigation measures. |
| NFR 10 | The system should categorize measures in a meaningful way, allowing users to analyze them based on relevant criteria. |
| NFR 11 | The system should present information in a progressive manner, starting with high-level overviews accessible to all users and gradually providing more detailed technical information for users seeking in-depth knowledge. |

6.3. Use Cases

The use cases serve as the final step before delving deeper into defining the architecture and design of the A&M Catalogue Tool. The initial version of these use cases, presented in the following sections,

has been tailored based on gathered feedback from each case study leader and expert recommendations in D2.7. Use cases delineate the system's executable functionalities, encapsulating the ultimate objectives from the perspective of the end-user.

The table below (Table 10) provides a comprehensive list and description of all the use cases initially employed by the A&M Catalogue Tool. For detailed information on a specific use case, more in-depth tables for each use case can be found in the annex, under the sections dedicated to general use cases within the ICT toolkit, specifically under A&M Catalogue section.

Table 10. Identified Use Cases and description for the A&M catalogue tool.

| Use case number | Use case name | Description |
|-----------------|--|--|
| UC0 | Assessment using the tool | The user wants to perform an assessment using the tool to learn platform features |
| UC1 | Search A&M Solutions | The user wants to search for specific terms and view all matching adaptation and mitigation solutions. |
| UC2 | Submit Solutions | The user wants to submit their own adaptation and mitigation solutions, sharing their experiences and successes for others to learn from. |
| UC3 | Navigate Cross-Sectoral Policies | The user wants to access high-level cross-sectoral policies to gain a comprehensive view of climate adaptation and mitigation measures. The user wants to access information in a progressive manner, starting from high-level overviews and gradually accessing more detailed technical information. |
| UC4 | Select A&M Solution | The user wants to analyse measures based on relevant criteria by utilizing the system's categorization. The user wants to analyse and assess the synergies, trade-offs, potential impacts, scale dimension, effectiveness type of policy, sector, location (including climate and population density). The user wants to access information about how each measure can be financed, the success of each measure in other geographical areas, impact and outcomes. The user wants to access information and recommendations on how policies can be implemented and adapted to specific territorial areas. |
| UC5 | Download Factsheet | The user wants to download a factsheet or summary document for each policy, providing a concise and printable resource. |
| UC6 | Challenges | The user wants to understand the general challenges and considerations related to policies and solutions by connecting each measure to them. |
| UC7 | Filter by Geographic and Climatic Areas | The user wants to filter and search for policies based on geographical and climatic areas of application, ensuring relevance and suitability. |
| UC8 | Filter by Implemented Policies | The user wants to filter by policies that have already been implemented in other areas, learning from successful practices. |
| UC9 | Global tool | User wants to access global features related to selected AMS |
| UC10 | Local tool | User wants to access local features related to selected AMS |

6.3.1. A&M Catalogue Use Cases Diagram

This use case diagram is a visual representation of the functional requirements of the tool from an external perspective. It represents interactions between the system and its users (actors) to

accomplish the specific identified goals. It illustrates all the use cases presented before and how these use cases interact with different actors within the system. Also, an Actor Diagram is presented in this section (Figure 7).

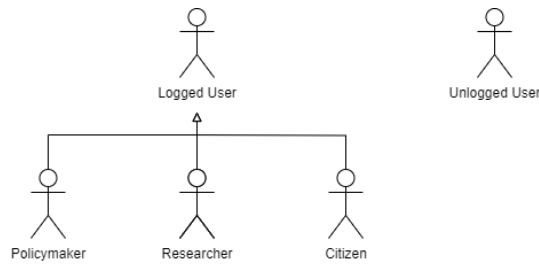


Figure 7. Generalized Actor Diagram for the A&M Catalogue tool.

The diagram displays two potential generalized actors: a logged user and an unlogged user. This distinction was made to account for the most complex scenarios considered in earlier stages of development. However, there is an ongoing discussion about whether the ICT toolkit will be accessible to both types of actors or if it will be limited to specific tools within the toolkit.

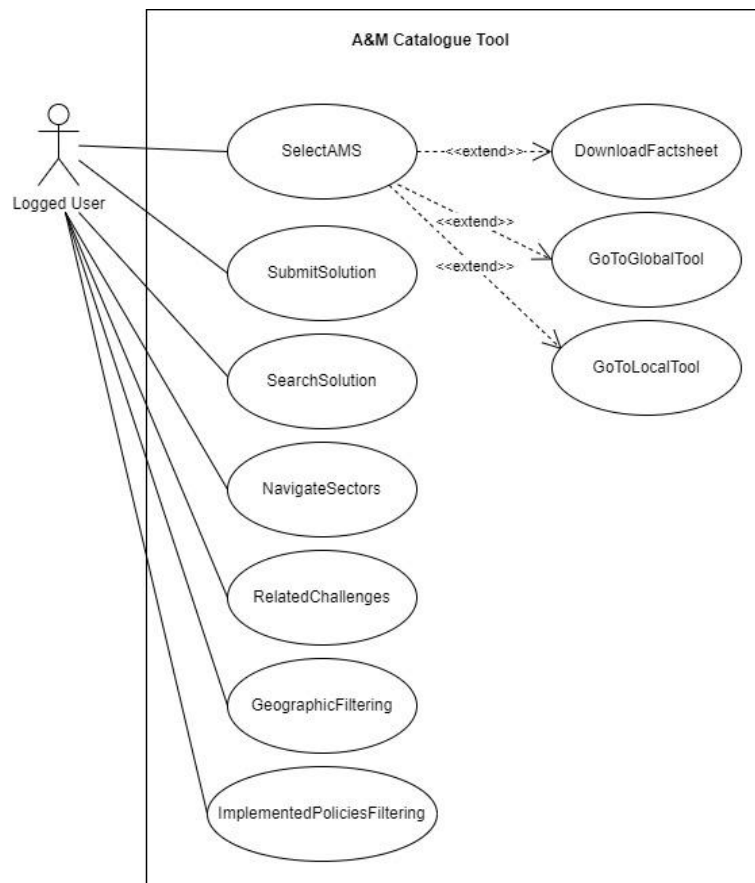


Figure 8. Use case diagram for the A&M catalogue.

Above (Figure 8), the use case diagram is displayed illustrating interactions between actors and use cases. For detailed information about a specific use case, more comprehensive tables for each use case can be located in the Annex II (13.2).

6.4. Mock-ups

The purpose of the mock-up is to introduce the platform to various external stakeholders, making it largely self-explanatory. It should be easily understandable in terms of both its offerings and

functionalities. This clarity should be evident both in its structure and design. Additionally, the mock-up serves to assist in the software development process.

In this section, a series of mock-ups is provided and detailed explanations accompany each. These mock-ups align with the use cases and functionalities discussed in the preceding sections, offering a visual representation of the concepts explained earlier.

In the following mock-up (Figure 9), the home landing page of the A&M Catalogue Tool is displayed. On the right panel, there is an initial description of the tool along with instructions on how to use it. The lateral buttons enable users to search for a specific Adaptation and Mitigation Solution (AMS) and filter data based on criteria such as "implemented policies," geographical area, or climate area. Additionally, users have the option to download a general factsheet.

In the central part of the screen the A&M solutions catalogue is shown. It is presented as a taxonomy tree graph, showing information in a hierarchical structure. It aims at presenting information in a progressive manner, starting with high-level overviews accessible to all users and gradually providing more detailed technical information. Each AMS is classified following this structure: from the root node primary sectors are born, each primary sector contains multiple secondary sectors, finally each secondary sector contains multiple AMS.

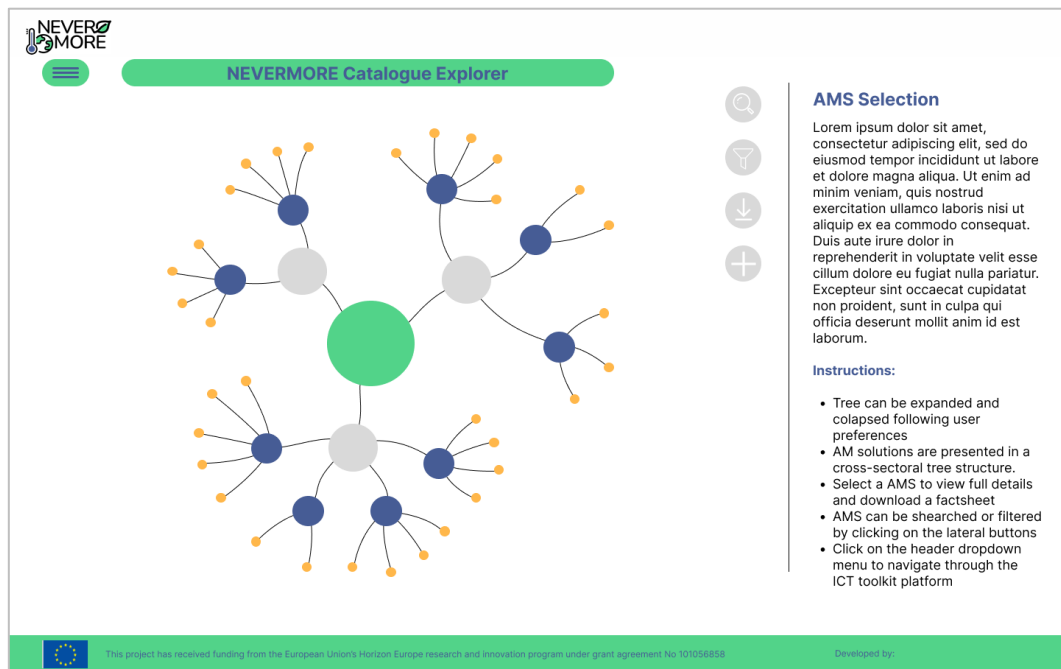


Figure 9. Initial interface of the A&M catalogue.

The next mock-up (Figure 10) showcases the extended dropdown menu located at the top-left corner of the interface. It enables users to explore various components within the ICT toolkit, navigate to the ICT toolkit platform's homepage, change language or access additional information. Furthermore, this section can accommodate other general use cases of the ICT platform, including functionalities such as user login or logout.

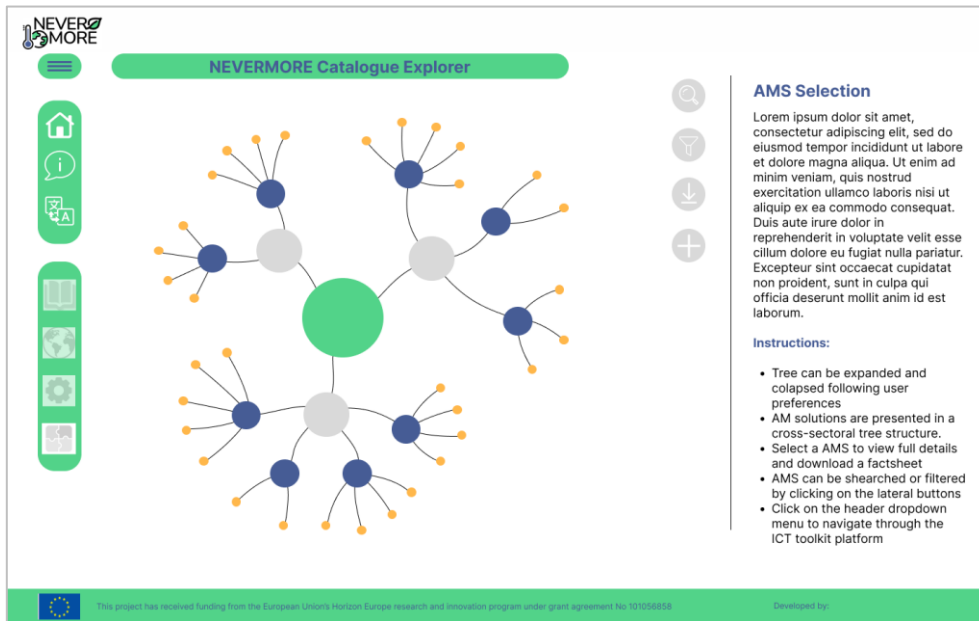


Figure 10. Initial view with the dropdown menu expanded.

An example view on how the taxonomy tree can be collapsed or expanded is shown in the following mock-up (Figure 11).

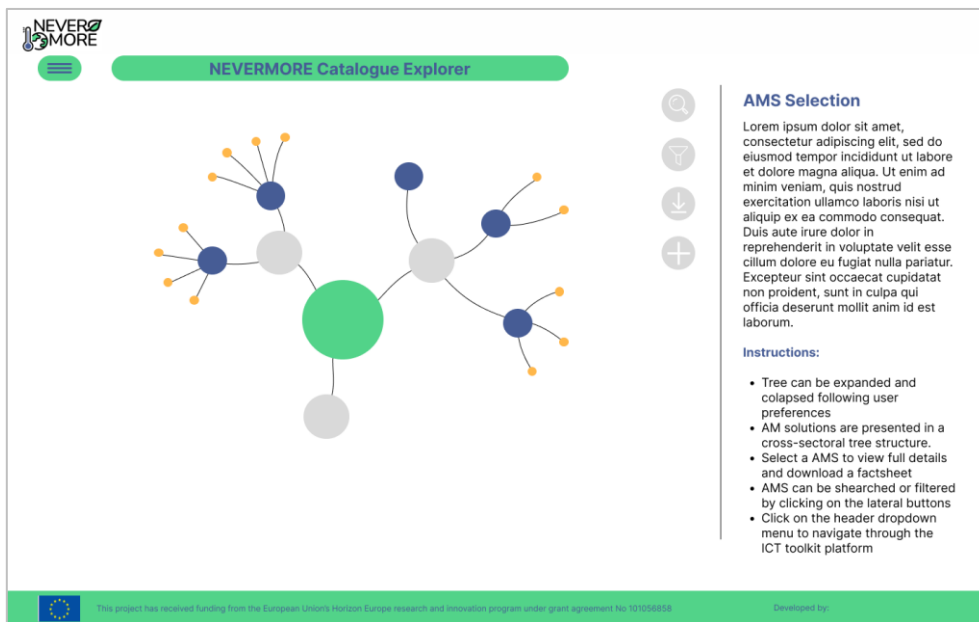


Figure 11. Interface to visualize the taxonomy solution implemented for the measures.

Finally, when an AMS is chosen, the user can download its factsheet, review information and details associated with the solution. The lateral panel also allows the user to easily navigate to related pages in the ICT tools (Figure 12).

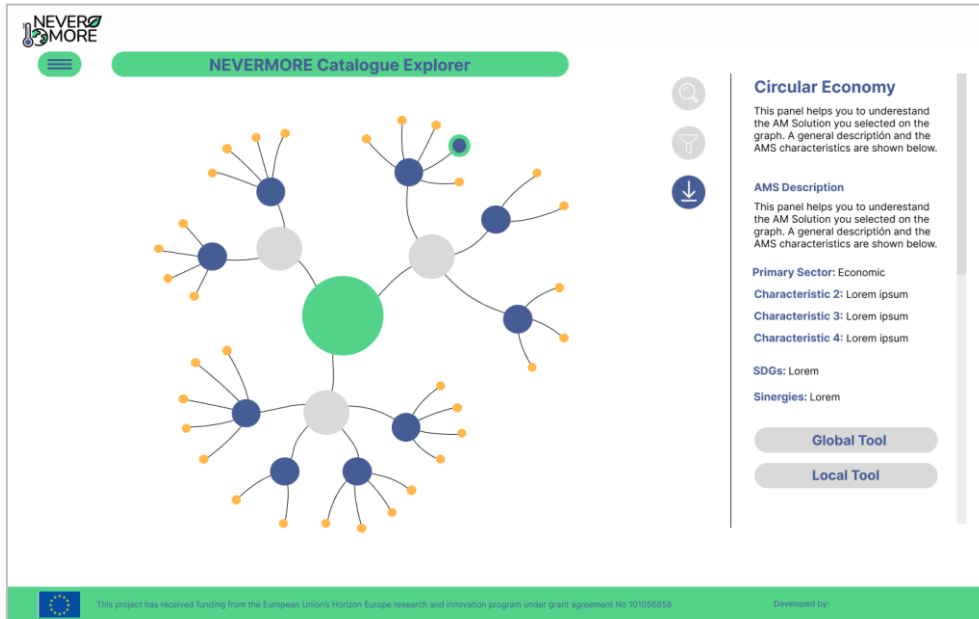


Figure 12. A&M interface to review and download the factsheets.

6.5. Architecture

In the upcoming section, we will outline the chosen technologies for the tool's development, providing an in-depth look at the architecture scheme. We will present an overview of the frontend, backend, and data storage components. It's important to note that, due to the early stage of development, there might be potential alterations to the technologies or the planned architecture. However, any such changes will have a minimal impact on the proposed scheme detailed in this section.

6.5.1. Selected Technologies

The frontend is planned to be implemented using Angular technology, which will integrate HTML and CSS views with logic and backend communication through TypeScript. The essential technologies for building a monolithic frontend application, including Node.js and NPM, will be utilized. Specific libraries such as d3.js for graphics presentation, filesaver.js for local storage, and the Clarity Design System for visual components are part of the planned implementation. Visual Studio is intended to serve as the primary Integrated Development Environment (IDE) for the development process.

Additionally, Git is planned to be used for version control and documentation management, while Figma has been employed for creating mock-ups. These secondary technologies are essential components of the planned development process, facilitating collaboration, version tracking, and visual design.

The backend of the A&M Catalogue is planned to be developed entirely in Python. It will utilize FastAPI to create endpoints for various operations such as retrieving detailed information about Adaptation and Mitigation Solutions (AMS), filtering solutions based on specific characteristics, and retrieving PDF files. The implementation will include data validation and serialization/deserialization of JSON objects to Python objects and vice versa. Additionally, an Object-Relational Mapping (ORM) library like SQLAlchemy will be employed to interact with the PostgreSQL database.

For data storage, PostgreSQL will be used as the database to store solution data. This involves designing appropriate tables to store solution characteristics such as id, name, description, sectors, scale, synergies, Sustainable Development Goals (SDGs), and other relevant information. If developed, factsheets will be stored in a file repository. The database will store file paths or URLs along with solution data, allowing seamless retrieval and organization of information.

6.5.2. Tool Architecture

The A&M Catalogue is designed to follow a monolithic architecture (Figure 13), adhering to the conventional structure of user interface, business layer, and data layer. This architectural framework translates into two core components: the frontend and the backend. The frontend encompasses the user interface, which will be developed using the Angular framework as discussed in the preceding section. Meanwhile, the backend comprises the majority of the business and data layers.

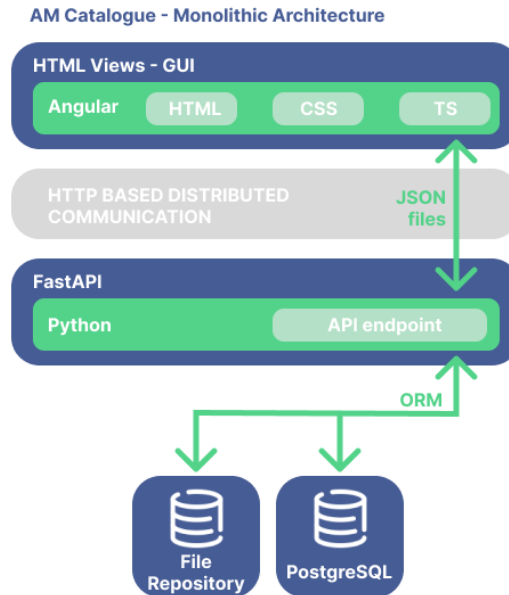


Figure 13. Monolithic architecture of the A&M Catalogue.

The backend implementation is planned to utilize FastAPI, enabling communication with the frontend through HTTP-based communication and JSON files. The API will also handle the logical operations necessary for pre-processing data before display in the user interface and the communication with the data layer. To facilitate this interaction, ORM (Object-Relational Mapping) techniques will be employed, utilizing SQLAlchemy. Within the data layer, two key endpoints are proposed: a PostgreSQL database containing AMS information and a file repository in case that factsheets are developed, providing a comprehensive and versatile foundation for the A&M Catalogue's data management. The diagram above provides a visual representation of the architecture of the A&M Catalogue

7. Case Study Tool

7.1. Introduction

The NEVERMORE Case Study tool will be a software component that allows users to select a case study and display the main climate change hazards (e.g. drought, floods, etc), impacts, vulnerabilities and risks. The information provided will be useful in order to create different adaptation and mitigation policy action scenarios based on measures selected by the user from the A&M catalogue at local scale. The Case Study tool will be built upon WP6 results and include downscaled climate datasets at local scale from the results of WP3.

7.2. Requirements

Requirements serve as both a description and specification of the desired system functionality, encompassing not only the system's actions but also its performance attributes. In this section, we

present the initial version of the requirements for the NEVERMORE case study tool, which were categorized into two different groups: functional requirements and non-functional requirements.

7.2.1. Functional requirements

Functional requirements have been identified by means of understanding of end user needs, the different scenarios for the usage of the tool and the specific actions required from both the Case Study tool and the ICT Toolkit. An initial version of these requirements, is presented in Table 11.

Table 11. Summary of the functional requirements for the NEVERMORE Case Study tool.

| Use case name | | Req. ID | Functional Requirement description |
|---|----------|---------|---|
| All | Any user | FR0 | The system should be able to provide an easy way to swith between tools or to return to the main page of the toolkit |
| Case study selection | Any user | FR1 | The system should allow to select a case study in order to implement an assessment based on his specificities |
| Evaluation of Case Study Data | Any user | FR2 | The system should allow to select and evaluate the different priority sectors at case study level |
| | | FR2.1 | The system should allow to review information on the main challenges |
| | | FR2.2 | The system should provide a clear explanation on the case studies |
| ECVs/Hazard Assessment | Any user | FR3.1 | The system should allow to select and plot different ECVs at case study level |
| | | FR3.2 | The system should allow to evaluate hazards and the main methods to collect information on them |
| Assets/Vulnerability/Risk visualization | Any user | FR3.1 | The system should allow to select the topic, the sector and the hazard in order to present the results at case study level |
| | | FR3.2 | The system should allow to check in a map the main results for each vulnerable sector |
| | | FR3.3 | The system should provide a complete explanation of the results at case study level |
| Vulnerability/Risk Sectoral Comparison | Any user | FR4.1 | The system should display graphs on vulnerability and risk by sector |
| | | FR4.2 | The system should allow to modify the hazard selection to present different results |
| Policy Priorities | Any user | FR5 | The system should allow users to define objectives and priorities by means of set of guided questions |
| Recommended Policies | Any user | FR6.1 | The system should allow to check the most relevant policies to be implemented for the user objectives and priorities |
| | | FR6.2 | The system should provide a clear explanation on the applicable policies and their effects |

7.2.2. Non-functional requirements

Non-functional requirements are focus on ancillary aspects, particularly concerning the tool performance and security. An initial version of these requirements is presented in Table 9.

Table 12. Summary of the non-functional requirements for the NEVERMORE Case Study tool.

| Req. ID | Functional Requirement description |
|---------|--|
| NFR 1 | The system should provide a user-friendly interface with easy navigation to ensure a smooth user experience |
| NFR 2 | The system should have an interface that can effectively display and handle the main modelling results ensuring accessibility and ease of use. |
| NFR 3 | The system should be responsive and provide quick access to information, minimizing loading times and delays in displaying data or results. |
| NFR 4 | The system should support multiple languages, allowing users to access information and navigate the tool in their preferred language. |
| NFR 5 | The system should implement appropriate security measures to protect user data, ensuring confidentiality, integrity and availability. |
| NFR 6 | The system should be designed with accessibility standards in mind, making it accessible to users with disabilities and complying with relevant accessibility guidelines |
| NFR 7 | The system should comply with data protection regulations and respect user privacy, implementing measures to secure and safeguard personal information. |
| NFR 8 | The system should be well-documented, providing clear instructions, guidelines, and user manuals for all the registered users. |
| NFR 9 | The system should include information on the relevant aspects at case study level |
| NFR 10 | The system should provide a connection to identify the most relevant policies from the A&M Catalogue. |
| NFR 11 | The system should present information in a progressive manner connecting the interfaces and the different steps with a fluent performance. |

7.3. Use Cases

The use cases serve as the initial step before going in deeper into defining the architecture and final design of the NEVERMORE case study tool. The initial version of these use cases, presented in this section, has been tailored based on the feedback collected in WP2 activities and the knowledge from WP7 partners, considering also previous initiatives and developments. Use cases, delineate the system's executable functions and functionalities, encapsulating the main objectives identified for the tool by the perspective of an end-user of the tool.

Table 13 provides a comprehensive list and description of all the use cases initially developed for building the NEVERMORE case study tool. For detailed information on each specific use, complete tables are included in the Annex III (13.3), that is dedicated to describe in depth the use cases built to explain the functionalities and the workflow for the NEVERMORE case study tool.

Table 13. List and use case description for NEVERMORE gamification tool.

| Use case number | Use case name | Description |
|-----------------|---|---|
| UC0 | Case Study Selection | The user selects the case study (from NEVERMORE) to be assessed by the tool |
| UC1 | Evaluation of Case Study Data | The user wants to uncover a general description of the case study selected and its relevant information about priority sectors and main challenges |
| UC2 | ECVs/Hazard Assessment | The user wants to visualize ECVs through graphs and discover information on main hazards in the selected case study |
| UC3 | Assets/Vulnerability/Risk visualization | The user wants to visualize map of assets, vulnerabilities and risks that change based on the selection of specific sectors and hazards, and to understand the process behind the assessments through the description provided in the information box |

| | | |
|-----|--|--|
| UC4 | Vulnerability/Risk Sectoral Comparison | The user wants to visualize the comparison between different sector for both vulnerability and risk. These are displayed in a graph form and they are based on the hazard selected by the user |
| UC5 | Policy Priorities | The user provides inputs (priorities and objectives) to obtain the most suited adaptation and mitigation measures for the case study |
| UC6 | Recommended Policies | The user must be able to visualize the policies that, after the previous selection of objectives, are recommended for the case study and their descriptions |

7.3.1. Use Cases Diagram for the case study tool

The use case diagram is a visual representation of the functional requirements of the tool from an external perspective. It represents the interactions between the system and its users (the actors) covering the specific goals identified during the consultations with stakeholders. This diagram illustrates all the use cases presented before and how these use cases interact with the different actors within the system. In addition, an Actor Diagram is presented (Figure 14) representing the interested actors for the case study tool and the necessity to be logged in the toolkit before the use of the tool.

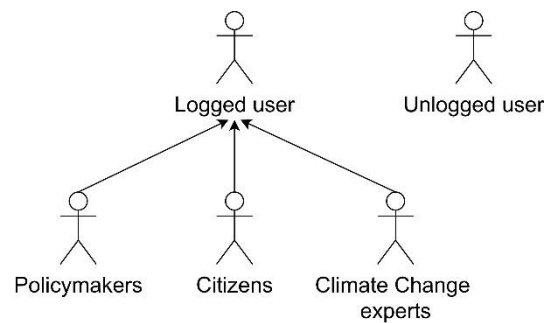


Figure 14. Generalized Actor Diagram for the NEVERMORE case study tool.

The use case diagram for the case study tool (Figure 15), is displayed for illustrating the interactions between actors and use cases. This is useful to understand the tool workflow and how the user could interact with each specific functionality of the tool. As it is represented in the diagram, the user needs to cover all the tool steps in order to implement a case study analysis. Detailed information of each specific use case, can be found in section 13.3 (Annex III).

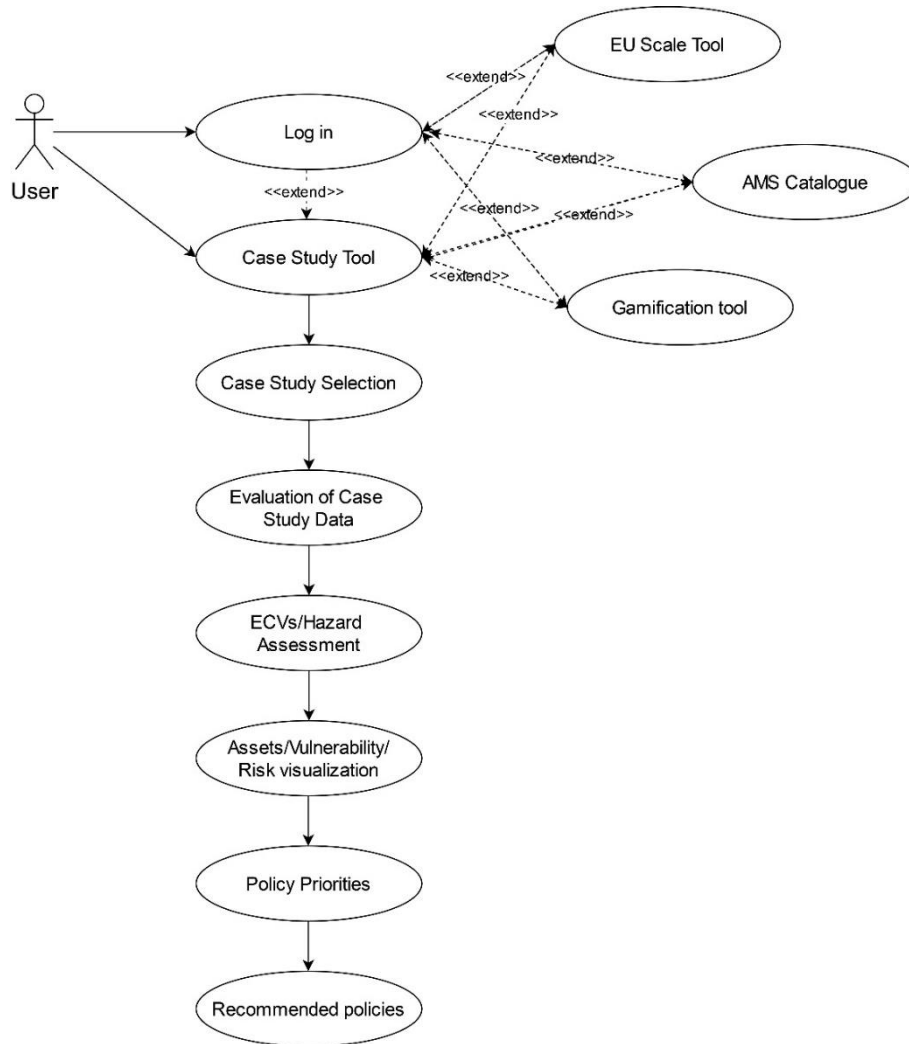


Figure 15. Use case diagram for NEVERMORE case study tool.

7.4. Mock-ups

The purpose of the mock-up is to introduce the tool to the different stakeholders, making it self-explanatory by mean of representations of the user interface according to the expected appearance and the functionalities. Mock-ups need to be easily understandable in terms of the visualizations that the tool is offering and the main provided functionalities. This clarity should be evident both in its structure and design. Additionally, the mock-ups will serve to assist developers in the software development process. In this section, a series of mock-ups is provided including detailed explanations to present the main objective of each view. These mock-ups are aligned with the use cases and the functionalities discussed in the previous sections, offering the visual representation of the concepts presented by the use cases.

Figure 16 presents the home page of the NEVERMORE Case Study Tool. It includes an initial description of the tool along with functionalities to select the most relevant case study for you to build an assessment. In addition, a bottom is included to click on them after the case study selection making feasible jumping to the next step in the tool. To complement this mock-up, Figure 17, present the same home page but in which the dropdown menu is expanded.

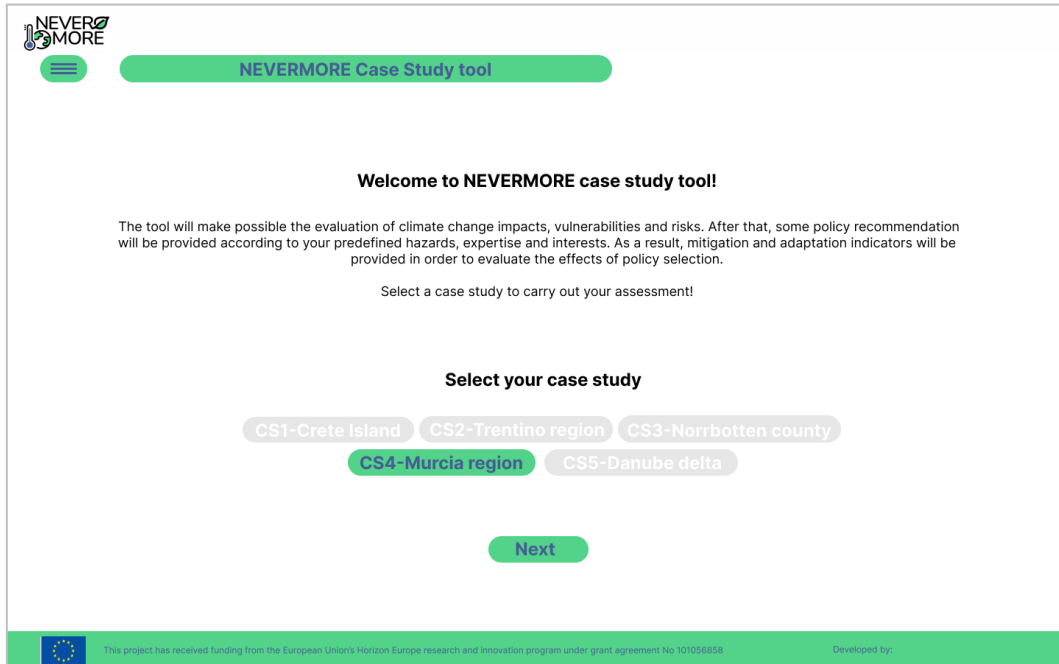


Figure 16. Home page of the NEVERMORE Case Study tool.

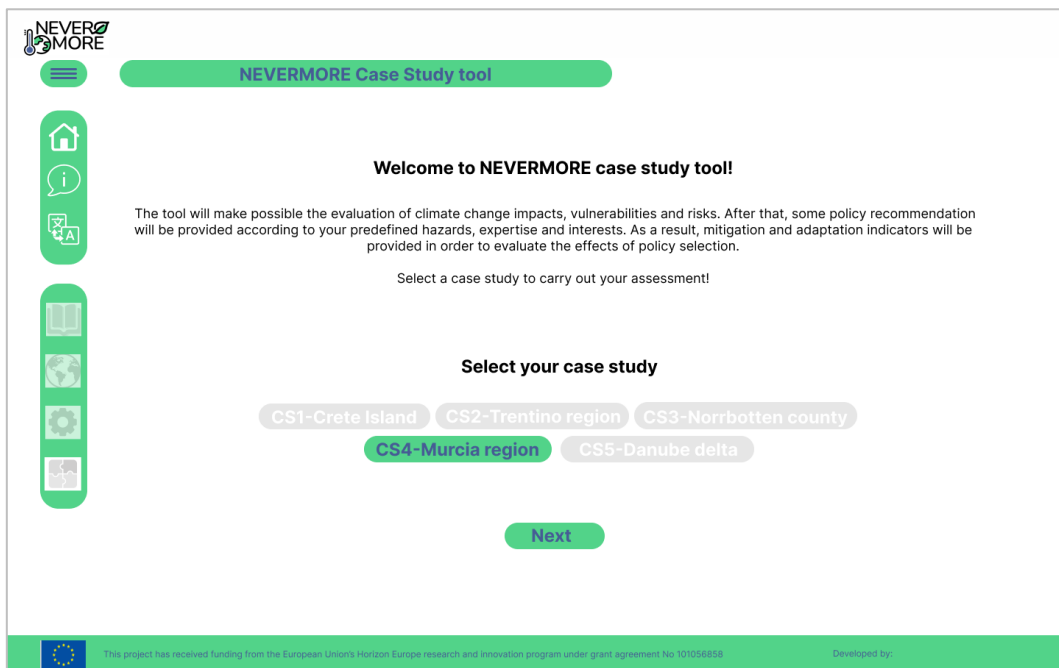


Figure 17. Home page of the NEVERMORE Case Study tool with a dropdown menu expanded.

After, the case study selection, the user will be able to evaluate in depth the selected case study. The provided information includes the priority sectors and the main challenges identified for each specific case study. The interface is presented in Figure 18. In the bottom part of the interface, the user will have the “Next” button to visualize ECVs and climate hazards.

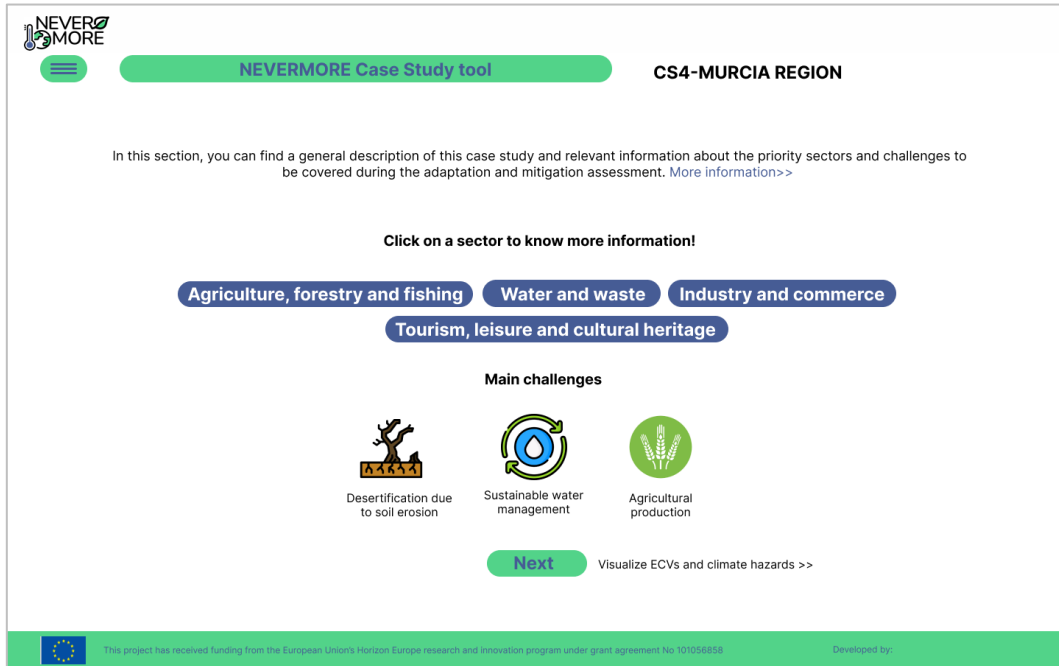


Figure 18. Interface for case evaluation. It includes functionalities for sector and challenges assessment.

The interface to evaluate ECVs and climate hazards (Figure 19), will include graphical visualization on the evolution of each variable (e.g. temperature, precipitation, etc). In parallel, the user will be able to select the hazard and the tool will open a pop-up with all the information related with the hazard. After that, you can continue visualising the assets, vulnerabilities and risks (Figure 20). This interface will plot in an easy-friendly way the results obtained for each case study under WP6 “Analysis of climate change impacts and risk at case studies” activities.

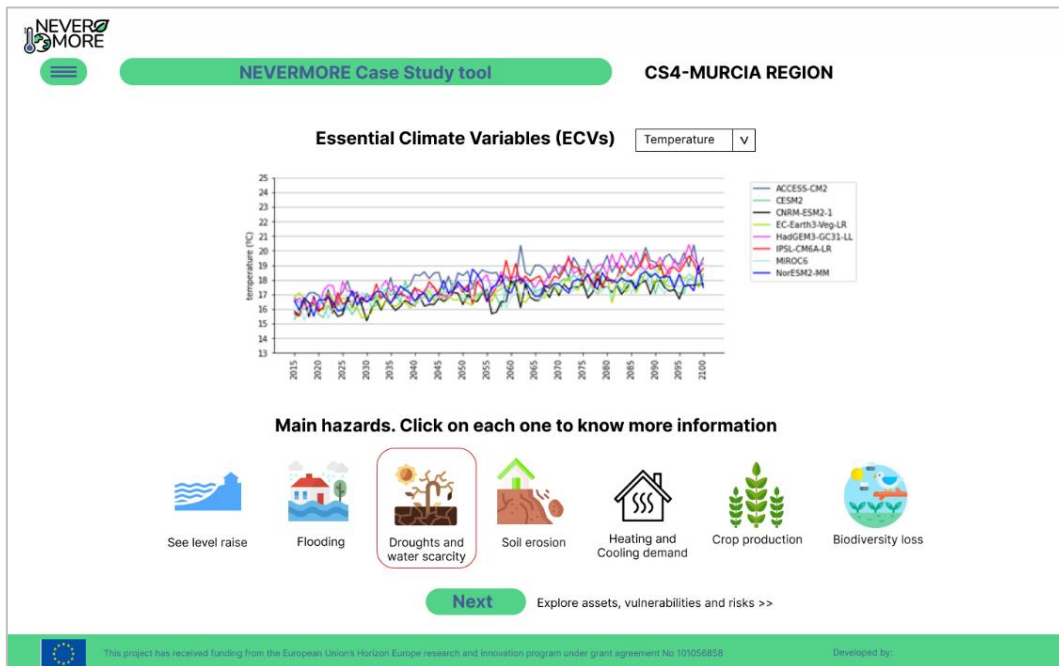


Figure 19. Interface of the Case Study tool to visualize ECVs and hazards.

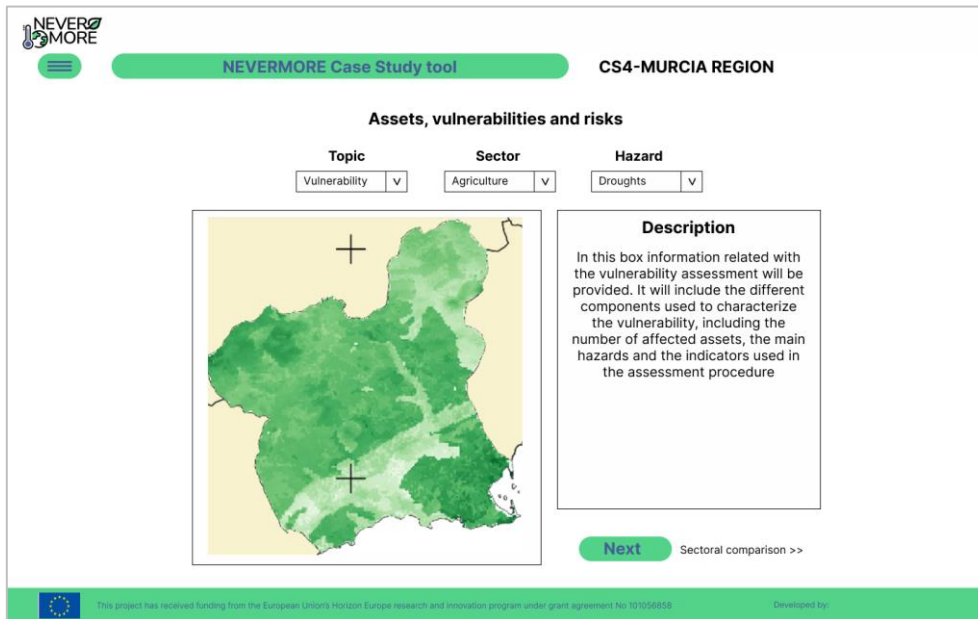


Figure 20. Interface to evaluate assets, vulnerabilities and risks.

To compare the results a new interface is provided in which the user is able to select the hazard by means of a dropdown menu plotting the risk and the vulnerability by sector for the case study (Figure 21). Once the results are checked, the user could continue with the tool in order to define priorities for policy identification

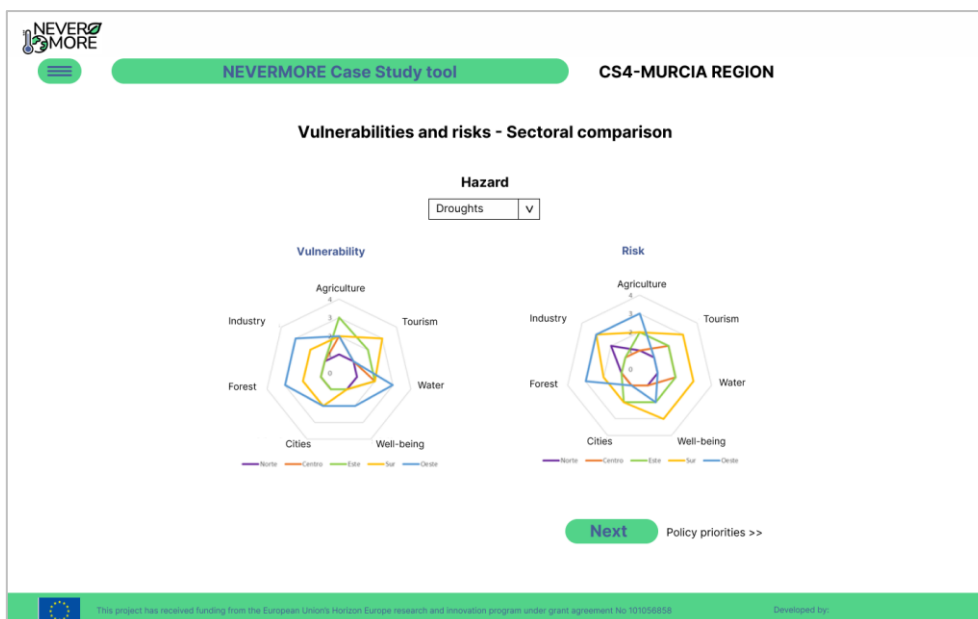


Figure 21. Interface for vulnerabilities and risk comparison by sector.

Once the user has checked all the issues related with the case study that is object of analysis, a new interface will be displayed (Figure 22) to include some priorities that will be the basis for policy selection. Thanks to a set of guided questions, the tool will make possible to identify the recommended policies necessary to improve the case study resilience. Policies will cover both, adaptation and mitigation. The interface is presented in Figure 23.

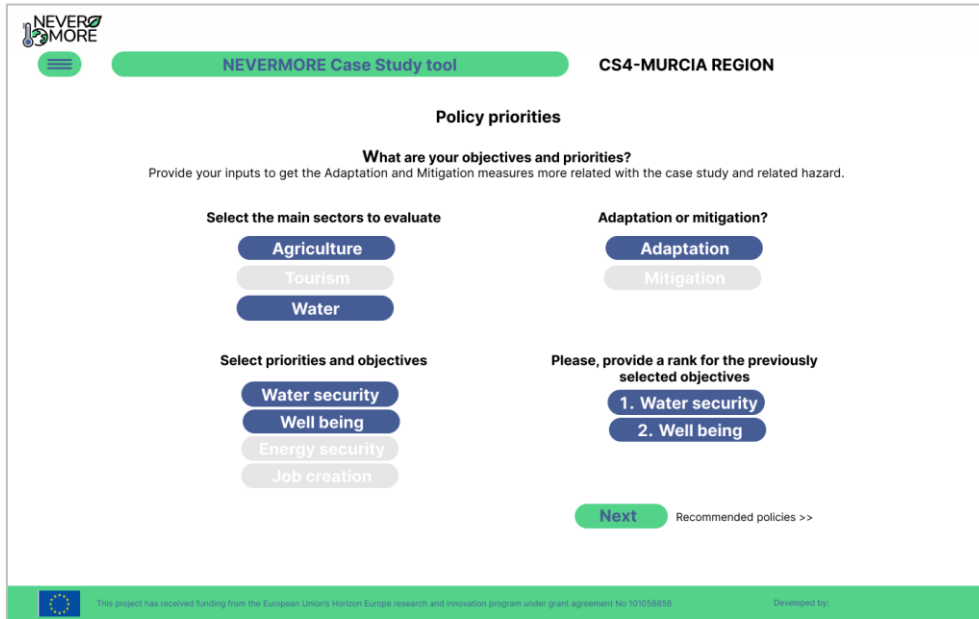


Figure 22. Policy prioritization interface using a guided questionnaire approach.

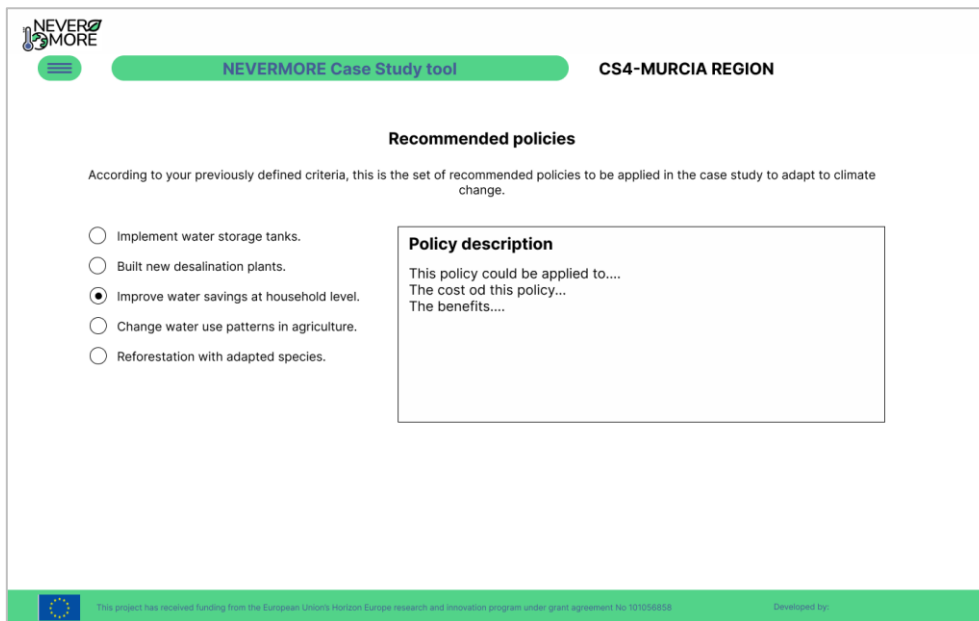


Figure 23. Policy recommendations interface.

7.5. Architecture

In this section, the initial steps will be taken to define the architecture of the service that will form the tool at the case study level. In addition, possible technologies will be detailed that will allow the development of all the functionalities contemplated in the design stage. Each of the tools is presented as a service to be integrated into the ICT toolkit, so variations could occur in terms of the definition of architecture and technologies.

7.5.1. Selected Technologies

The Case Study tool is planned to be implemented following a client-server architecture, represented by the three main typical layers: (i) Data layer; (ii) Business Logic Layer; and (iii) Application Layer. The first two layers of the tool architecture, comprise the tool backend, while the Application Layer

represents the tool frontend or the Graphical User Interface (GUI) making possible the user interaction. The technologies that could be used for the development of the application will be presented below.

The tool frontend will be based on Angular that is an open source JavaScript Framework written in TypeScript. Its main objective is to develop single page applications. A framework is a conceptual and technological support structure defined, generally, with specific software artifacts or modules, which can serve as a basis for the organization and development of software. For the backend, two alternatives could be used: Python or Java. For the first one, FastAPI could be the first option. FastAPI is a fast and lightweight web framework for building modern application programming interfaces using Python. For Java, a good alternative could be Spring Boot that is a tool for facilitate the development of microservices and web applications with the Java Spring Framework. PostgreSQL storage could be the best option for the implementation of the multiple databases necessary to build de tool.

7.5.2. Tool Architecture

As it was previously defined, the Case Study tool is planned to be implemented following a client-server architecture, represented by the three main typical layers: (i) Data layer; (ii) Business Logic Layer; and (iii) Application Layer. The main components of the tool architecture are included in Figure 24.

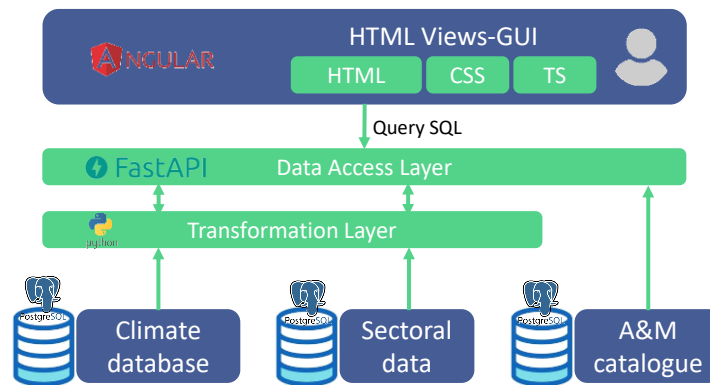


Figure 24. Monolithic architecture of the Case Study tool.

8. EU-Scale Tool

8.1. Introduction

In this section a general introduction to the tool, its scope and connection with the overall NEVERMORE and other Tools will be presented, alongside with the tool’s developing motivation.

The goal of the tool is to become a “policymaking tool” that could offer relevant policy recommendations. The tool will be using pre-simulated data results from WILIAM Integrated Assessment Model (WILIAM IAM), in order to decrease the complexity through the means of lowering the degree of freedom of the client input variables. This filtering and reduction of inputs will be done using the stakeholders’ knowledge

8.2. Requirements

The upcoming lists of requirements have been generated according to the experience with similar tools in previous projects. Thanks to this, all the important requirements have been properly detected and added to the lists. These requirements have been split into functional and non-functional requirements.

8.2.1. Functional requirements

The functional requirements (Table 14) include everything related to the procedures, incidences and features that are directly related to the software, and consequently are usually shared by the majority of similar computer tools.

Table 14. Functional requirements for EU Scale tool.

| Use case name | | Req. ID | Functional Requirement description |
|-----------------|----------------------|---------|---|
| Scenario | Registered users | FR 1.1 | The EU global tool should allow any registered user to create a new policy action scenario |
| | | FR 1.2 | The EU global tool should allow the registered users to delete their own scenarios. |
| | | FR 1.3 | The EU global tool should allow any registered user to modify the previous developed scenarios |
| Assessment | Registered users | FR 2.1 | The EU global tool should allow the user to visualize the assumptions included during the model implementation by means of a suitable explanation of each assumption. |
| | | FR 2.2 | The EU global tool should allow the user to compare pre-defined scenarios (if any) included in the tool. |
| | | FR 2.3 | The EU global tool should allow the user to create their own scenario selecting the most suitable assumptions and policies, and compare it respect to the pre-defined scenarios included in the tool. |
| | | FR 2.4 | The EU global tool should allow the user to obtain an explanation of each policy during scenario development to select the most suitable policies according to the scenario requirements. |
| | | FR 2.5 | The EU global tool should allow the user to visualize the results of the created scenario by means of relevant graphs. |
| | | FR 2.6 | The EU global tool should allow the user to select different graphs to visualize the final results of the created scenario. |
| | | FR 2.7 | The EU global tool should allow the user to visualize a summary of the selected policies and the impacts of their implementation |
| Export scenario | For registered users | FR 3.1 | The EU global tool should allow the user to export the results of the scenario including all the policies chosen for its development |
| Forum/chat box | Any user | FR 4.1 | The system should provide a tool for sharing comments and opinions between users to foster a greater interactivity for the tool. |

8.2.2. Non-functional requirements

In this case, the requirements are related to the experience of the user (accessibility, language) and the contents (questions and options, data). Alongside with the description it is included the correspondences with the requirements addressed in D2.7. Some of the EU-Scale Tool (EST) indicated in Table 15 are also covered in the Functional Requirements too.

Table 15. Non-functional requirements for EU Scale tool.

| Req. ID | Functional Requirement description | Correspondence with D2.7 |
|---------|---|--------------------------|
| NFR 1 | The system should provide a user-friendly interface with easy navigation to ensure a smooth user experience | EST01, EST03 |
| NFR 2 | The system should have an interface that can effectively display and handle a large number of policies, ensuring accessibility and ease of use. | |

| | | |
|--------|---|--------------|
| NFR 3 | The system should be responsive and provide quick access to information, minimizing loading times and delays in displaying data or results. | EST01 |
| NFR 4 | The system should support multiple languages, allowing users to access information and navigate the tool in their preferred language. | |
| NFR 5 | The system should implement appropriate security measures to protect user data, ensuring confidentiality, integrity, and availability. | |
| NFR 6 | The system should be designed with accessibility standards in mind, making it accessible to users with disabilities and complying with relevant accessibility guidelines | |
| NFR 7 | The system should comply with data protection regulations and respect user privacy, implementing measures to secure and safeguard personal information. | |
| NFR 8 | The system should be well-documented, providing clear instructions, guidelines, and user manuals for users and administrators. | |
| NFR 9 | The system should include high-level cross-sectoral policies to provide a comprehensive view of climate adaptation and mitigation measures. | |
| NFR 10 | The system should categorize measures in a meaningful way, allowing users to analyse them based on relevant criteria. | EST04, EST08 |
| NFR 11 | The system should present information in a progressive manner, starting with high-level overviews accessible to all users and gradually providing more detailed technical information for users seeking in-depth knowledge. | EST02, EST07 |
| NFR 12 | The economic impact of the measures has to be reflected on each and every policy available and decision taken. | EST05 |
| NFR 13 | The system should have a way to identify the kind of user (citizen, policy maker) in order to offer a personalized experience on the tool. | EST06 |

8.3. Use Cases

The current set of use cases (Table 16) has been elaborated through the feedback of the partners and the previous experience obtained during the design of similar tools. The full set of use cases with the whole details is specified in the Annex chapter.

Table 16. Use cases for the EU Scale tool.

| Use case number | Use case name | Description |
|-----------------|------------------------------------|--|
| UC0 | Assessment using the tool. | The user wants to perform an assessment using the tool to learn platform features |
| UC1 | Create new scenario. | The user selects values for the policies in order to generate a scenario |
| UC2 | Navigate created scenarios. | The user wants to check the scenario resultant from the policies selection, playing with the graphics |
| UC3 | Export scenario. | The user saves the data and scenario results into a file |
| UC4 | Go back to main entrance. | The user wants to go back to the main app to change some personal data from the registration or to access to another program |
| UC5 | Show model assumptions. | The users must be able to visualize all the model parameters that are stablish in a constant value during the model simulation |
| UC6 | Save scenario. | The user wants keep the policies values selected as a scenario for future consultation |

| | | |
|------|-----------------------------------|--|
| UC7 | Change simulation scale. | The user wants to change the scale of the simulation in order to get broader or specific results |
| UC8 | Share scenario. | The user wants to share one of his scenarios with other users connected |
| UC9 | Interact with other users. | The user shares messages in real time with other users |
| UC10 | Compare scenarios. | The user needs to visualize two scenarios in order to compare the simulation results |

8.3.1. Use Cases Diagram for the case study tool

An Actor Diagram is presented (Figure 25) representing the interested actors for the EU-Scale tool and the necessity to be logged in the toolkit before the use of the tool.

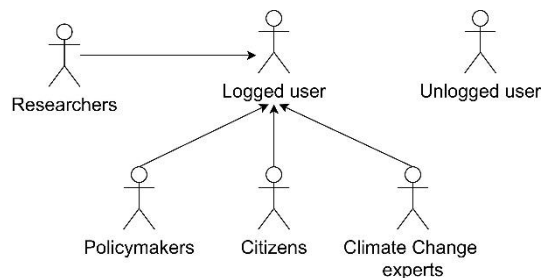


Figure 25. Generalized Actor Diagram for the NEVERMORE EU-scale tool.

The use case diagram for the EU-Scale tool (Figure 26), is displayed for illustrating the interactions between actors and use cases. This is useful to understand the tool workflow and how the user could interact with each specific functionality of the tool. As it is represented in the diagram, the user needs to cover all the tool steps in order to implement a case study analysis. Detailed information of each specific use case, can be found in section 13.4 (Annex IV).

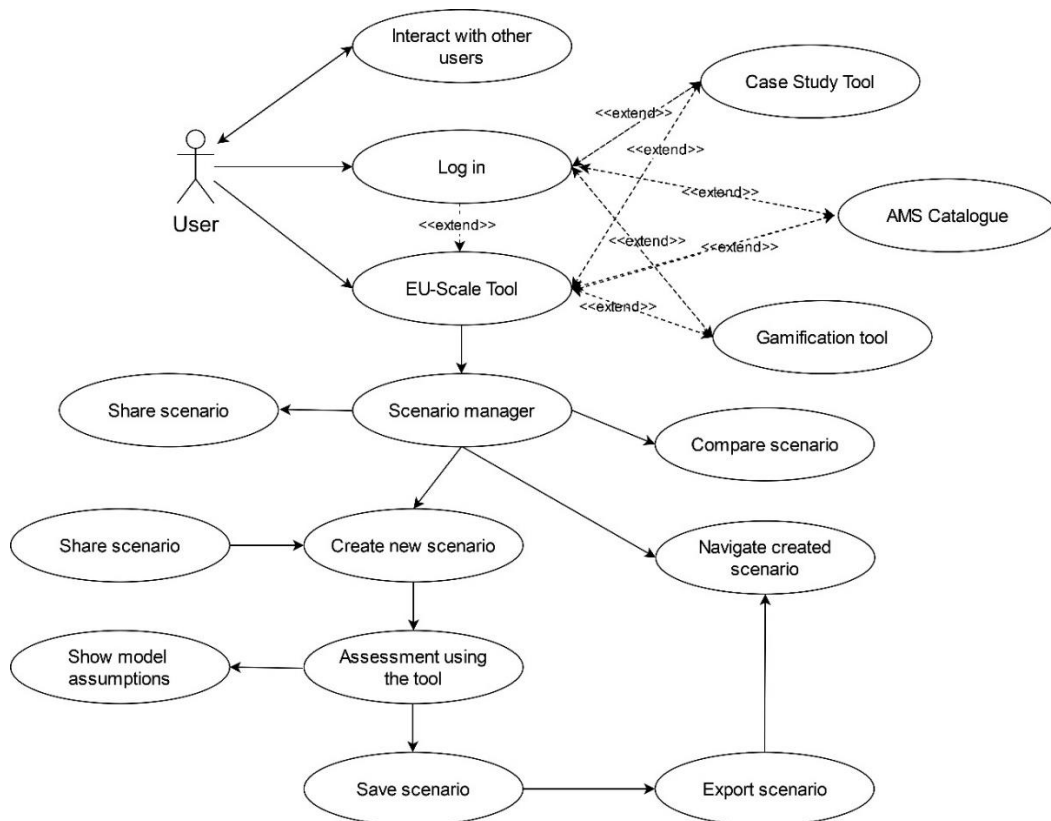


Figure 26. Use case diagram for NEVERMORE EU-Scale tool.

8.4. Mock-ups

In this section, the first design of the NEVERMORE EU scale tool is proposed. Most of the features proposed for the tool were identified in D2.7 “Report on socio-technological requirements” and are included in this first draft, and the ones not yet included will have to be discussed, in order to reach a compromise in the design and usability of the tool. The tool will be accessed through the common platform, and consequently there is no need to create a specific set of interfaces for the user management due to these issues are covered in the main entrance for the tools. Once the user is registered and/or has logged into the system, the user will select the tool and automatically redirected to main page of the tool (Figure 27 and Figure 28).

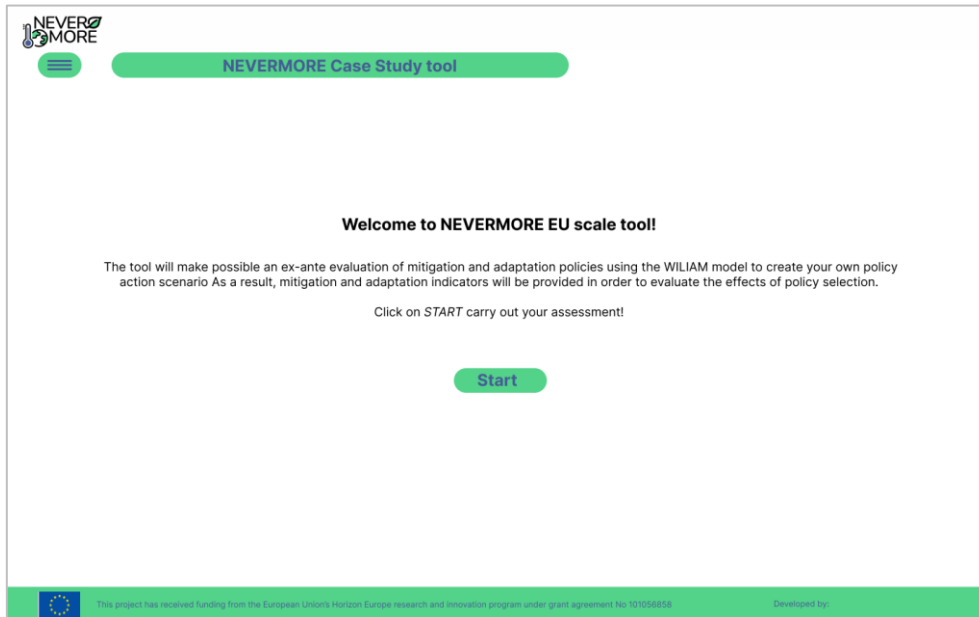


Figure 27: Main interface for the EU Scale tool.

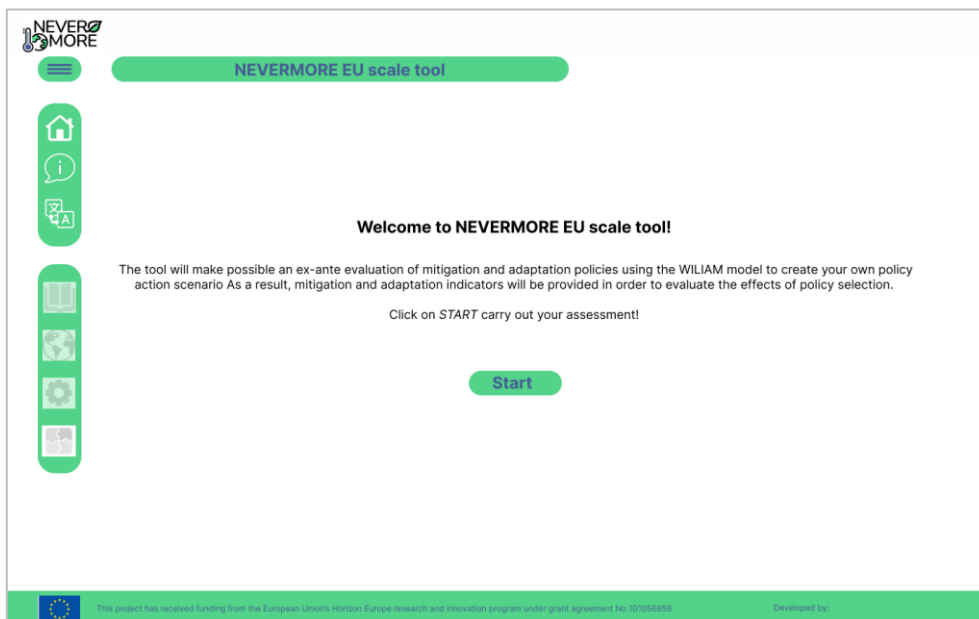


Figure 28: Main interface for the EU Scale tool with the dropdown menu visible.

After clicking on “Start” the user will be re-directed to the list of scenarios. In this view, the user will be able to create new scenarios (Figure 29), evaluate the public ones as well as the private (Figure 30

and Figure 31). Functionalities to search scenarios, modify the scenario typology and filter the public, private (owner) and all the scenarios will be provided. When all the scenarios are visible, the user will have the opportunity to compare two scenarios by selecting them before the comparison (Figure 32). In addition, a chat is included in order to provide a place to exchange knowledge between the tool users and collaborate in the implementation of policy action scenarios, in order to cover the corresponding functional requirement.

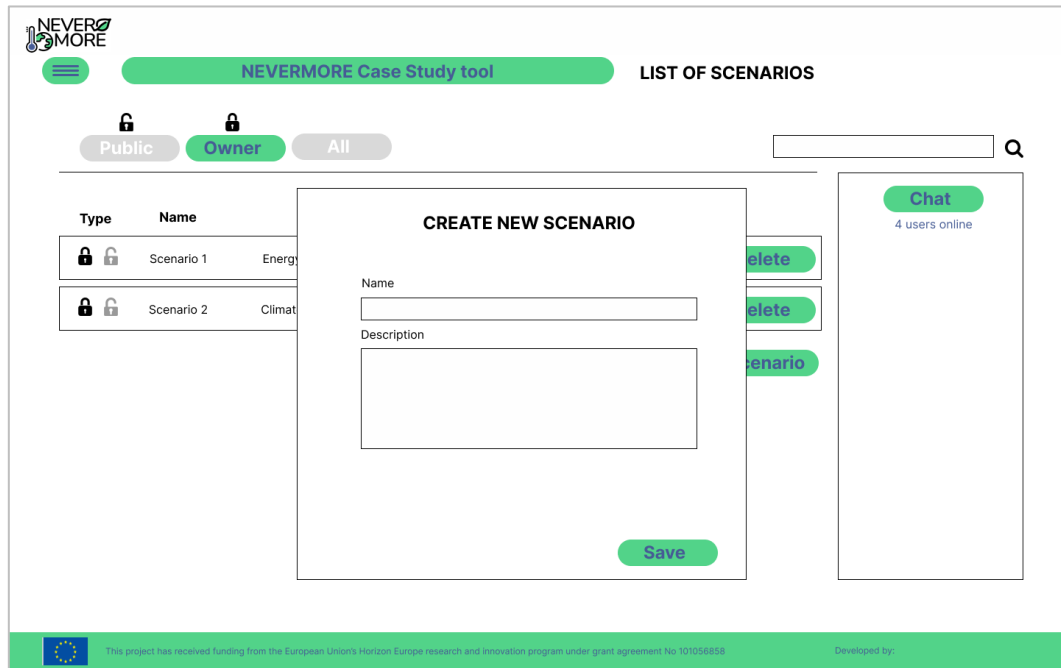


Figure 29: Create a new scenario using the EU-scale tool.

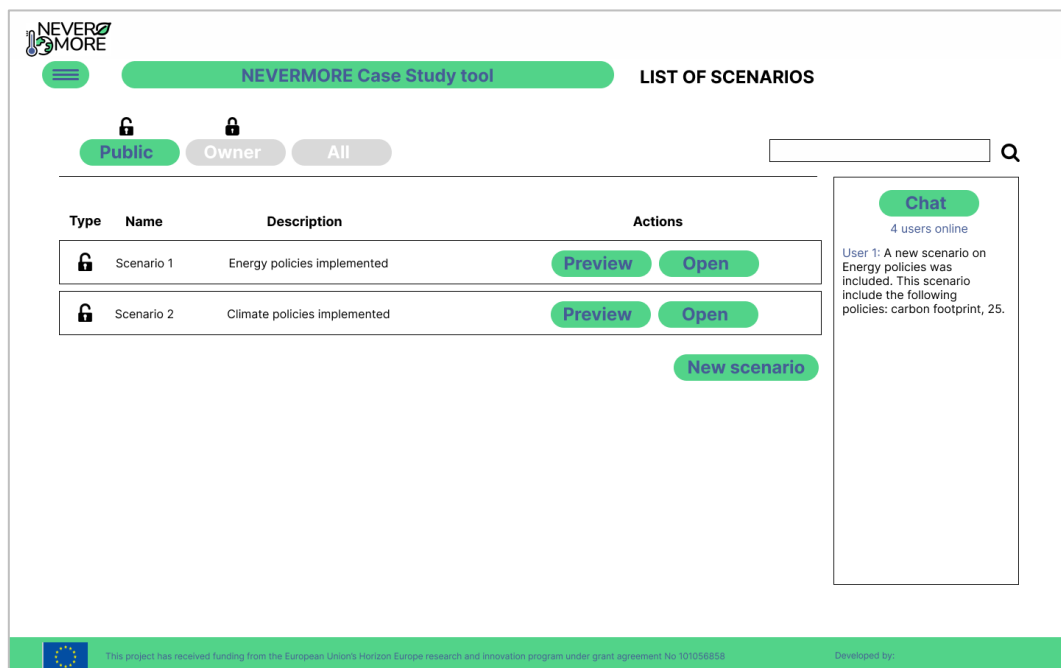


Figure 30: Interface for the list of scenarios with only public scenarios selected.

The communication chat has been proposed according to the following criteria:

- The users of the tool have to be registered, so they become responsible of the information and content distributed through this channel of communication (this will be communicated in a disclaimer to new users when proceeding to register).
- The information deployed in the chat can be easily reviewed both for technical and legal issues.
- Other means of communication between users, like video or audio are harder to implement, have some software and hardware requirements that are not always easy to fulfil, and the recordings of these communications are cumbersome to handle, and also have their own specific legal issues.
- The chat provides an accessible tool for everyone, in terms of visualization and software or hardware requirements. In addition, the bandwidth required for such communications is reasonably small, compared to other collaborative tools.

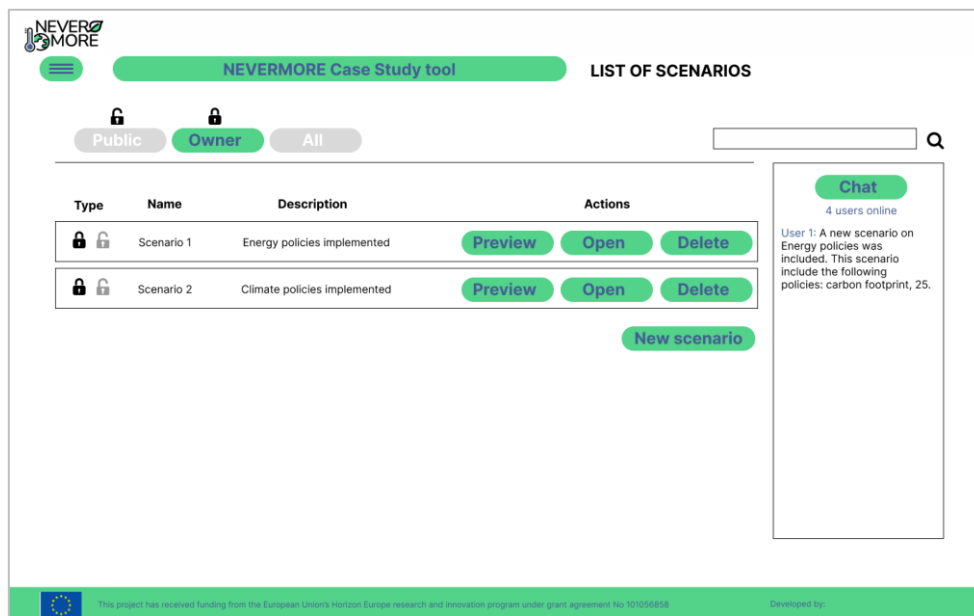


Figure 31: Interface for the list of scenarios with only private scenarios selected.

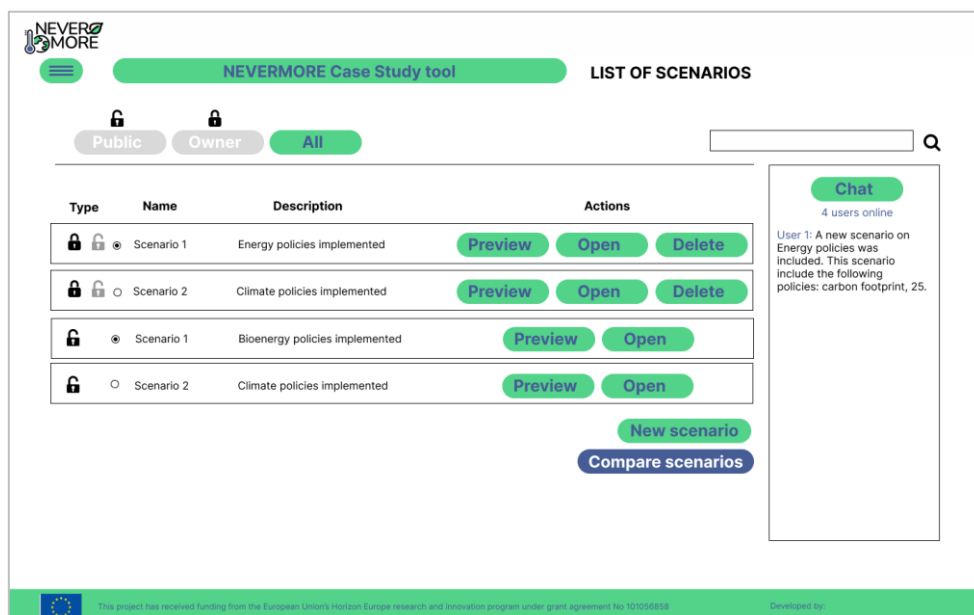


Figure 32: Interface for the list of scenarios with both (public and private scenarios) available for comparison.

In the *scenario parametrization*, the user will be able activate and modify the policies (Figure 33). Each policy value can be changed through the use of a slider when the policy is activated (Figure 34). Once the scenario policies have the chosen values, the user can generate the scenario by means of the “Apply” button. Once the scenario is calculated, the user needs to save it in order to store the results in the database (Figure 35). In the *scenario manager*, the user will be able to change the typology of a scenario making it public to be shared with other users. To increase the visibility, the user will have the opportunity to post in the chat explaining the created scenario.

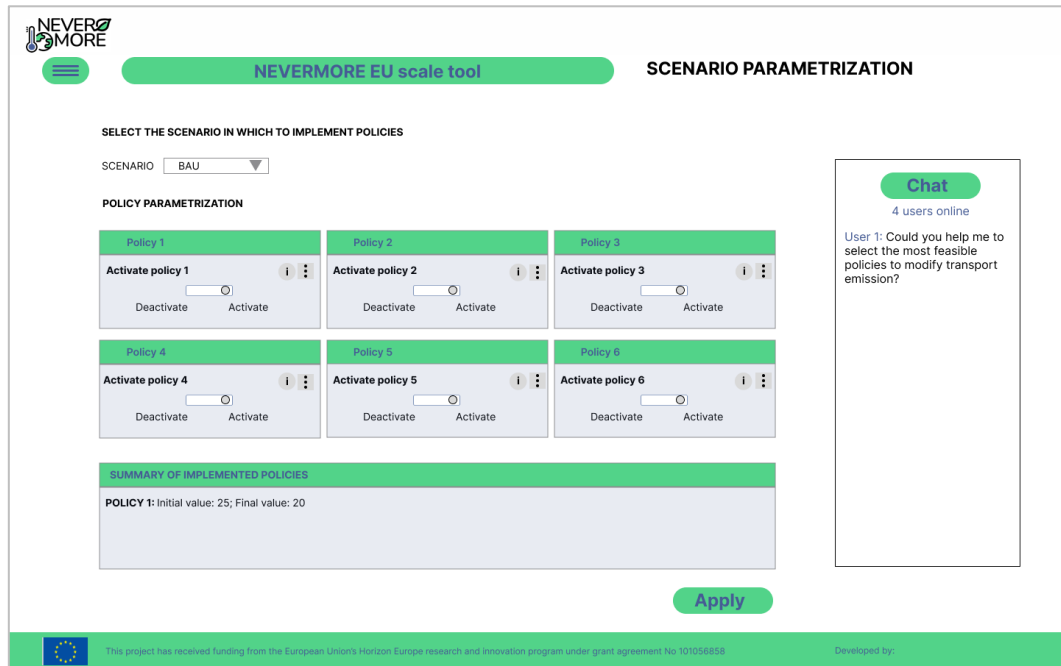


Figure 33: Main page for policy selection in the EU-scale tool.

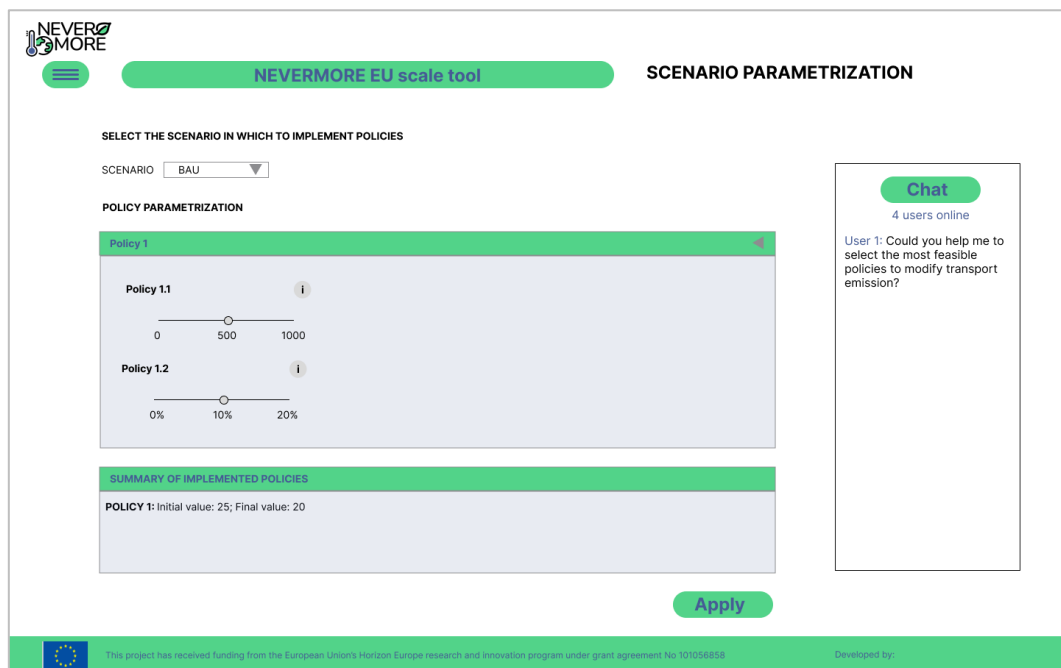


Figure 34: Design of the view for policy parametrization.



Figure 35: Design of the view for results evaluation using a selected scenario.

When the results are displayed, the user will be able to evaluate the *Model Assumptions* as the main hypothesis included in the model. To this end, panel with the model assumptions will pop up, in order to inform the experts about the values and fixed parameters of the model. Finally, the tool will have an interface for scenario comparison (Figure 36). This interface is connected with the scenario manager in which the user needs to provide the selection of the two scenarios for comparison. Once the two scenarios are selected, the user will be able select the indicator, compare results using a set of selected indicators and evaluate the main policies implemented to obtain the results.

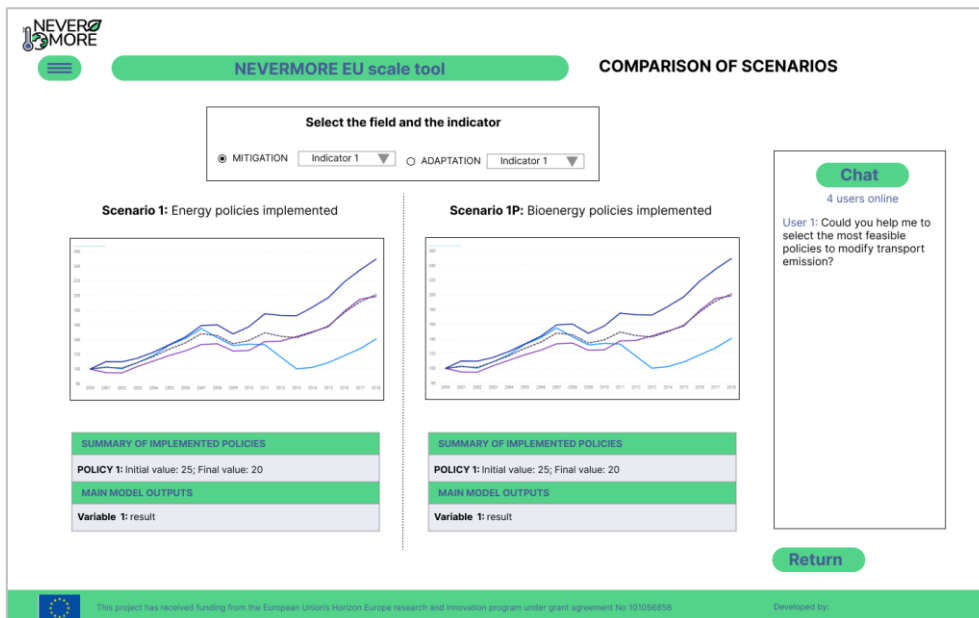


Figure 36: Interface to compare two scenarios.

8.5. Architecture

This sub chapter includes one section describing the different technologies that will be applied in the design and construction of the software solution, and another section for the architecture of the tool. Due to the early stage of development, these descriptions should be only considered as a draft that

could change greatly in order to get its usability fit into the proposals from the involved partners and stakeholders.

8.5.1. Selected Technologies

Considering the technologies that have to be involved during the whole process, from the design to the final deployment, the combination of well-known technologies used in previous projects with the selection of open source tools is the best option.

This early proposal of technologies in terms of the programming languages has to consider both sides of the solution, the frontend and backend, as it is commented in the Tool Architecture sub chapter.

There are multiple popular solutions for frontend applications online right now, and one of them is using JavaScript, concretely the React library that can offer versatility and variety of solutions and easiness of use. Another feasible alternative could be Angular. Moreover, it can be integrated with many other technologies when we have to consider the connections to remote databases or devices networks and these solutions would work correctly in the most popular browsers, as well as the visuals can be properly adapted to different devices such as tablets or mobile phones. Other technologies like Bootstrap or node.js can be applied when they could offer better and easier solutions. For example, Bootstrap is ideal to organize visual elements and define the relations between them, facilitating also the visualization in different devices.

About the backend, it will include a proper PostgreSQL database fed with the simulation values, and a security system shared by the four tools. The technology proposed could be Keycloak, a project supported by the same people from Red Hat that is openly available through a GitHub page.

The coding would be developed with IDEs such as Atom, that is a simple editor, or with more complex tools like Visual Studio, just to name the most popular nowadays. Other options could include Fast API and related technologies.

The teams would be collaborating between them thanks to the use of Git tools that contain interesting features like chats and forums, and a branch system that facilitates parallel development.

For the management and maintenance of PostgreSQL databases one option is DBeaver, although there are other interesting options like pgAdmin.

8.5.2. Tool Architecture

This tool is going to be part of the larger solution, and it has been stated that they will share a common entering gate. In order to facilitate this, in the part of the frontend the tool will better use the same technologies deployed for the other solutions, that will comprise the programming languages and libraries previously commented.

As long as the tool will work online, the simplest architecture includes two distinctive areas corresponding the frontend and backend, as it has been commented. The frontend technologies will be handled through software applications like Angular or similar ones, depending on the development team skills. For the backend, FastAPI joint a .NET application will be used ensuring the connectivity between the frontend, the simulated results and the real time simulation approach using a computation Server. The first definition of this architecture is presented in Figure 37.

Concepts like modularity will accept the global architecture of the tool, considering that it is easier to create and maintain the code when it is composed of several working parts instead of a unique piece of code, even considering the initial separation between frontend and backend. The different modules could separate functionalities, but also will be in different locations (loaded in the browser and consulted in the remote server), and would be programmed in different languages, facilitating the coordination between front and backend designers.

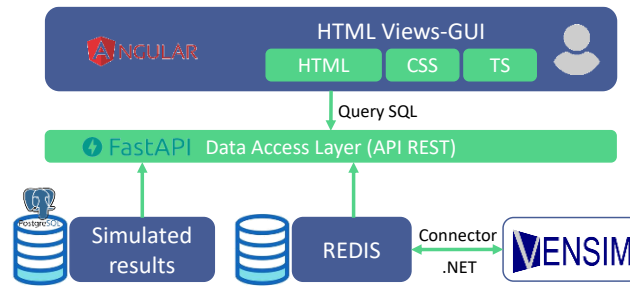


Figure 37. Monolithic architecture of the EU-Scale tool.

9. Gamification Tool

9.1. Introduction

The main objective of NEVERMORE gamification tool is to create awareness about climate change. It is developed as an educational simulation game where players explore different solutions to fight and adapt to the impacts of climate change. The game teaches players about the impacts of climate change while inspiring hope and motivating users to act and find effective solutions that will help to define a greener, better adapted and safe future. The game players must complete two different missions to finish the game. In mission one, players will explore pathways to reduce greenhouse gas (GHG) emissions applying solutions. Decisions in the first mission will lead players to a high, medium or low carbon scenario in mission two. In this second mission, players will be able to select one of the five NEVERMORE case studies (mountain, Mediterranean, boreal/northern, island and east of EU-Wetland) and must act to prepare the communities for the impacts of climate change. The game will be able for execution as an individual player or to compete in groups in order to create consensus on the measures to be applied. In group dynamics, players will have the opportunity to discuss between them (face-to-face or using a chat) in order to identify the most suitable solutions and choose the best option according to the budget and the impact in terms of GHG emissions and adaptation effects. The proposal of developing mission is close to Illuminate approach (Chan & Leung, 2020) while the mitigation ideas were collected from previous experiences from MEDEAS (Capellán-Pérez, Álvarez-Antelo, & Miguel, 2019) and LOCOMOTION project (Ramos, et al., 2023).

9.2. Requirements

Requirements serve as both a description and specification of the desired system functionality, encompassing not only the system's actions but also its performance attributes. In this section, we present the initial version of the requirements for the NEVERMORE gamification tool, which were categorized into two different groups: functional requirements and non-functional requirements.

9.2.1. Functional requirements

The functional requirements (Table 17) include everything related to the procedures, incidences and features that are directly related to the software, and consequently are usually shared by the majority of similar computer tools.

Table 17. Functional requirements for the Gamification tool.

| Use case name | | Req. ID | Functional Requirement description |
|---------------------|----------|---------|--|
| All | Any user | FR0 | The system should be able to provide an easy way to change between tools or to return to the main page of the toolkit |
| Selection Tool Mode | Any user | FR1 | The system should allow users to select the playing mode |

| | | | |
|-------------------------------|----------|--------|---|
| Role Selection | Any user | FR2 | The system should allow users to select the role between different preselected ones |
| Mitigation Assessment | Any user | FR3 | The system should allow users to define the most suitable policies on mitigation as individual player |
| Mitigation Results | Any user | FR4.1 | The system should allow users to evaluate the mitigation results thanks to graphs and visual elements |
| | | FR4.2 | The system should allow users to select an indicator to be reviewed |
| Adaptation Assessment | Any user | FR5.1 | The system should allow users to select the case study based on the suggestions provided by the tool |
| | | FR5.2 | The system should allow users to select the main hazard to work in the adaptation based on the recommendations provide by the tool |
| Policy Selection | Any user | FR6 | The system should allow users to select and implement relevant adaptation policies |
| Adaptation Indicators | Any user | FR7 | The system should allow users to analyse the effects of adaptation policies including also the benefits and cost of inaction |
| Group/Role Selection | Any user | FR8 | The system should allow users to select the role between different preselected ones and the group as a team player |
| Team Mitigation Assessment | Any user | FR9.1 | The system should allow users to define the most suitable policies on mitigation as team players |
| | | FR9.2 | The system should allow users to chat for a consensus on the implemented policies |
| Team Mitigation Results | Any user | FR10.1 | The system should allow users to evaluate the mitigation results thanks to graphs and visual elements |
| | | FR10.2 | The system should allow users to select an indicator to be reviewed |
| Results Comparison Mitigation | Any user | FR11 | The system should allow users to compare mitigation results from all the teams of participants |
| Team Adaptation Assessment | Any user | FR12.1 | The system should allow users to select the case study based on the recommendations |
| | | FR12.2 | The system should allow users to select the main hazard to work in the adaptation based on the recommendations |
| Policy Selection | Any user | FR13.1 | The system should allow users to select and implement relevant adaptation policies |
| | | FR13.2 | The system should allow users to chat for a consensus on the implemented policies |
| Results Comparison Adaptation | Any user | FR14 | The system should allow users to compare adaptation results from all the teams of participants |

9.2.2. Non-functional requirements

Non-functional requirements are focus on ancillary aspects, particularly concerning the tool performance and security. An initial version of these requirements is presented in Table 18.

Table 18. Summary of the non-functional requirements for the NEVERMORE Case Study tool.

| Req. ID | Functional Requirement description |
|---------|--|
| NFR 1 | The system should provide a user-friendly interface with easy navigation to ensure a smooth user experience |
| NFR 2 | The system should have an interface that can effectively display and handle the main modelling results ensuring accessibility and ease of use. |
| NFR 3 | The system should be responsive and provide quick access to information, minimizing loading times and delays in displaying data or results. |

| | |
|--------|--|
| NFR 4 | The system should support multiple languages, allowing users to access information and navigate the tool in their preferred language. |
| NFR 5 | The system should implement appropriate security measures to protect user data, ensuring confidentiality, integrity and availability. |
| NFR 6 | The system should be designed with accessibility standards in mind, making it accessible to users with disabilities and complying with relevant accessibility guidelines |
| NFR 7 | The system should comply with data protection regulations and respect user privacy, implementing measures to secure and safeguard personal information. |
| NFR 8 | The system should be well-documented, providing clear instructions, guidelines, and user manuals for all the registered users. |
| NFR 9 | The system should include information on the relevant aspects for each player |
| NFR 10 | The system should provide a connection with pre-simulated results of WILIAM model |
| NFR 11 | The system should present information in an easy to understand language |
| NFR 13 | The system should include tool to engage and communicate between player |
| NFR 12 | The system should create awareness on adaptation and mitigation |

9.3. Use Cases

The use cases serve as the initial step before going in deeper into defining the architecture and final design of the NEVERMORE gamification tool. The initial version of these use cases, presented in this section, has been tailored based on the feedback collected in WP2 “Stakeholder engagement, co-design activities and social science for climate action” activities and the knowledge from WP7 “ICT toolkit design, development and deployment” partners, considering also previous initiatives and developments. Use cases, delineate the system's executable functions and functionalities, encapsulating the main objectives identified for the tool by the perspective of an end-user of the tool.

Table 19 provides a comprehensive list and description of all the use cases initially developed for building the NEVERMORE gamification tool. For detailed information on each specific use, tables are included in the Annex V (section 13.5), that is dedicated to describe in depth the use cases built to describe the functionalities and the workflow for the NEVERMORE gamification tool.

Table 19. List and use case description for NEVERMORE gamification tool.

| Use case number | Use case name | Description |
|-----------------|-----------------------|---|
| UC0 | Selection Tool Mode | The user is able to select the mode for using the Gamification tool between individual player and group dynamic |
| UC1 | Role Selection | The user is able to select role that will be necessary to provide useful policy recommendation before policy implementation in the Game |
| UC2 | Mitigation Assessment | The user is able to select the necessary policies to mitigate climate change |
| UC3 | Mitigation Results | The user is able to evaluate the mitigation results after answering the question (policy implementation) |
| UC4 | Adaptation Assessment | The user is able to select the case study among the NEVERMORE case studies and the hazard object to adaptation |
| UC5 | Policy Selection | The user is able to select the set of policies necessary to adapt to climate change |
| UC6 | Adaptation Indicators | The user is able evaluate the results of adaptation policies and the costs |
| UC7 | Group/Role Selection | The user is able to select the group and the role that will be necessary to provide useful policy recommendation before policy implementation in the Game |

| | | |
|------|-------------------------------|--|
| UC8 | Team Mitigation Assessment | The user is able to select the necessary policies to mitigate climate change |
| UC9 | Team Mitigation Results | The user is able to evaluate the mitigation results after answering the question (policy implementation) |
| UC10 | Results Comparison Mitigation | The user is able to compare the mitigation results of the different choices by the teams on policy questions |
| UC11 | Team Adaptation Assessment | The user as part of a group, is able to select the case study among the NEVERMORE case studies and the hazard object to adaptation |
| UC12 | Policy Selection | The user is able to select the set of policies necessary to adapt to climate change |
| UC13 | Results Comparison Adaptation | The user is able to compare the mitigation results of the different choices by the teams on policy questions |

9.3.1. Use Cases Diagram for the gamification tool

The use case diagram is a visual representation of the functional requirements of the tool from an external perspective. It represents the interactions between the system and its users (the actors) covering the specific goals identified during the consultations with stakeholders. This diagram illustrates all the use cases presented before and how these use cases interact with the different actors within the system. In addition, an Actor Diagram is presented (Figure 38) representing the interested actors for the tool and the necessity to be logged in the ICT toolkit before the use of the tool.

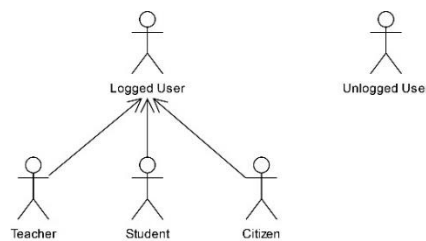


Figure 38. Generalized Actor Diagram for the NEVERMORE gamification tool.

The use case diagram for the gamification tool (Figure 39), is displayed for illustrating the interactions between actors and use cases. This is useful to understand the tool workflow and how the user could interact with each specific functionality. As it is represented in the diagram, two different pathways are provided. The first one is related with an individual use of the tool while the second is covering the use of the tool in group dynamics to create consensus on the climate decision. Detailed information of each specific use case, can be found in Annex V (section 13.5).

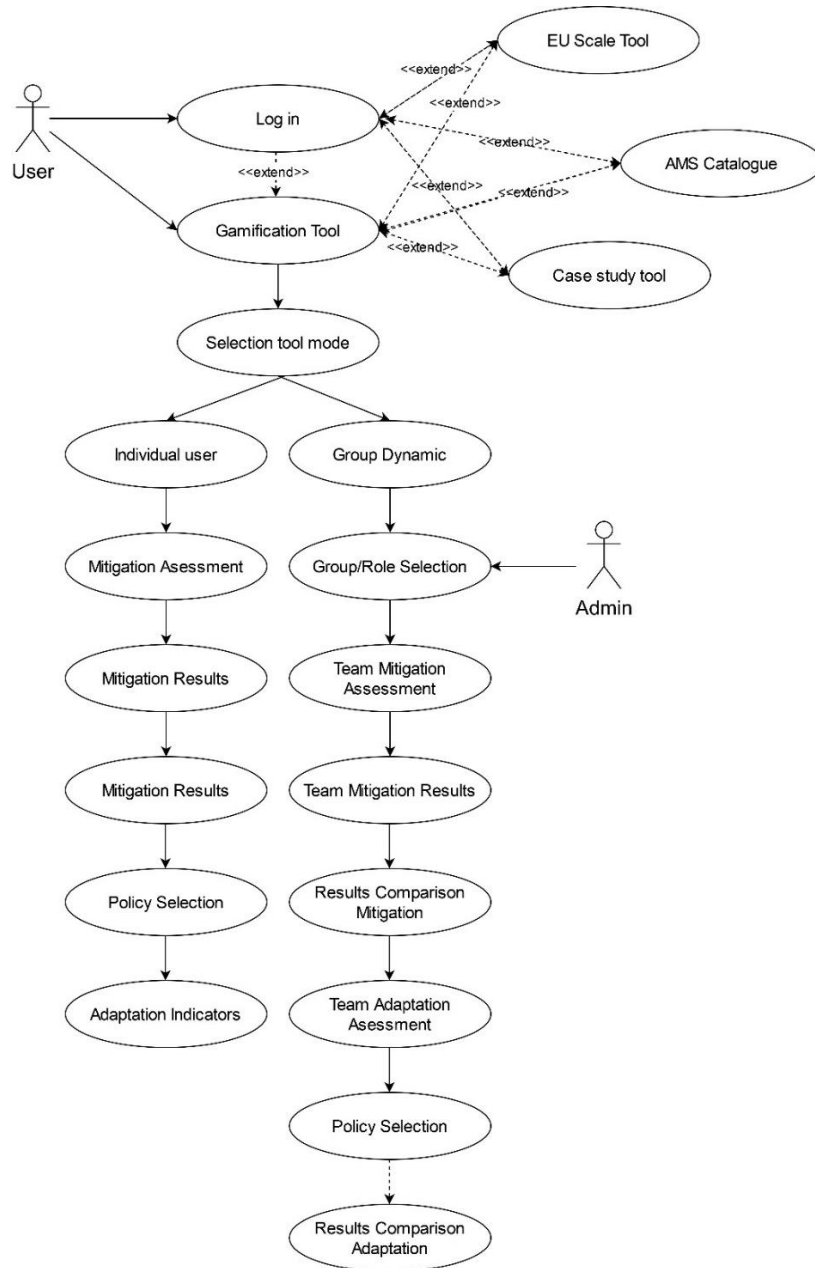


Figure 39. Use case diagram for NEVERMORE gamification tool.

9.4. Mock-ups

The purpose of the mock-up is to introduce the tool to the different stakeholders, making it self-explanatory by mean of representations of the user interface according to the expected appearance and the functionalities. In this sense, Figure 40 presents the home page of the NEVERMORE Gamification Tool. It includes an initial description of the tool along with functionalities to select the playing option. Two different options are provided: individual user or group dynamics. To complement this mock-up, Figure 41, present the same home page but in which the dropdown menu is expanded.

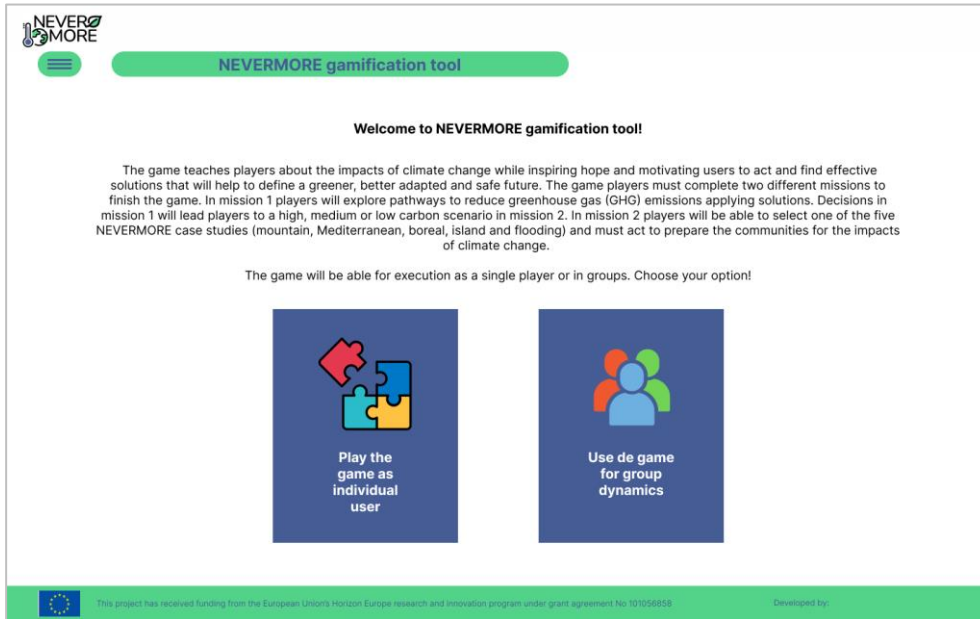


Figure 40: Main interface for the Gamification tool.

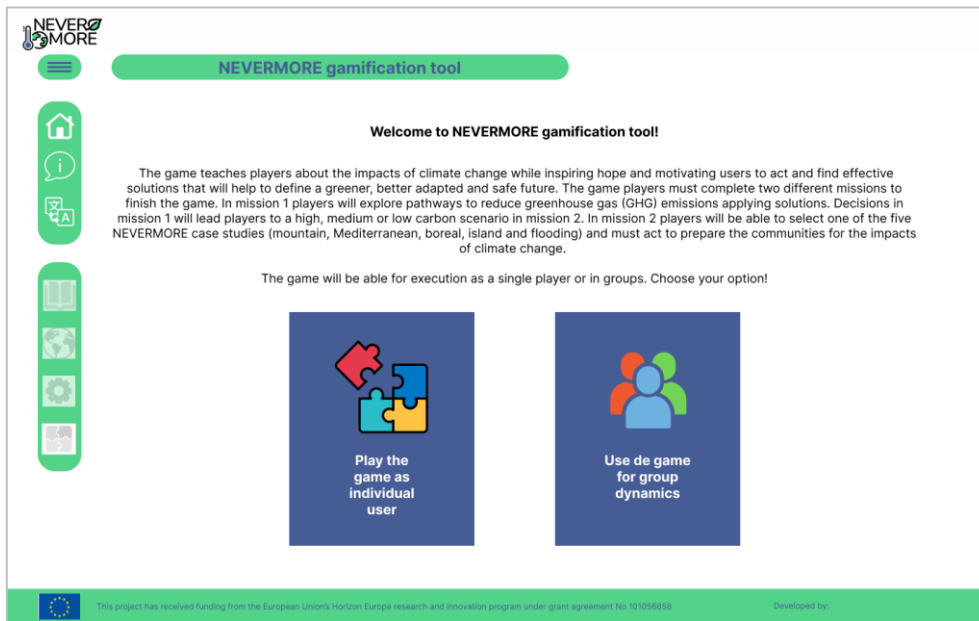


Figure 41: Main interface for the Gamification tool with the dropdown menu expanded.

Once the user selects the playing mode, different option will be provided. Playing as individual user, he will have the opportunity of selecting a role between four different options: Energy expert, environmental expert, economy expert and social expert (Figure 42). This selection will be essential in order to provide some policy recommendations guiding them during the different steps of the tool.



Figure 42: Interface for role selection.

As it was explained before, the role selection is critical to ensure a good selection of the policies to be implemented. These policies will be included by means of questions (Figure 43) connected with the main parameter and results of WILLIAM model. After a set of question, you will be able to apply the changes and visualise the results using graphs and indicators (Figure 44). Dropdown menus will be included in order to select the most relevant indicator to be represented in the graph.

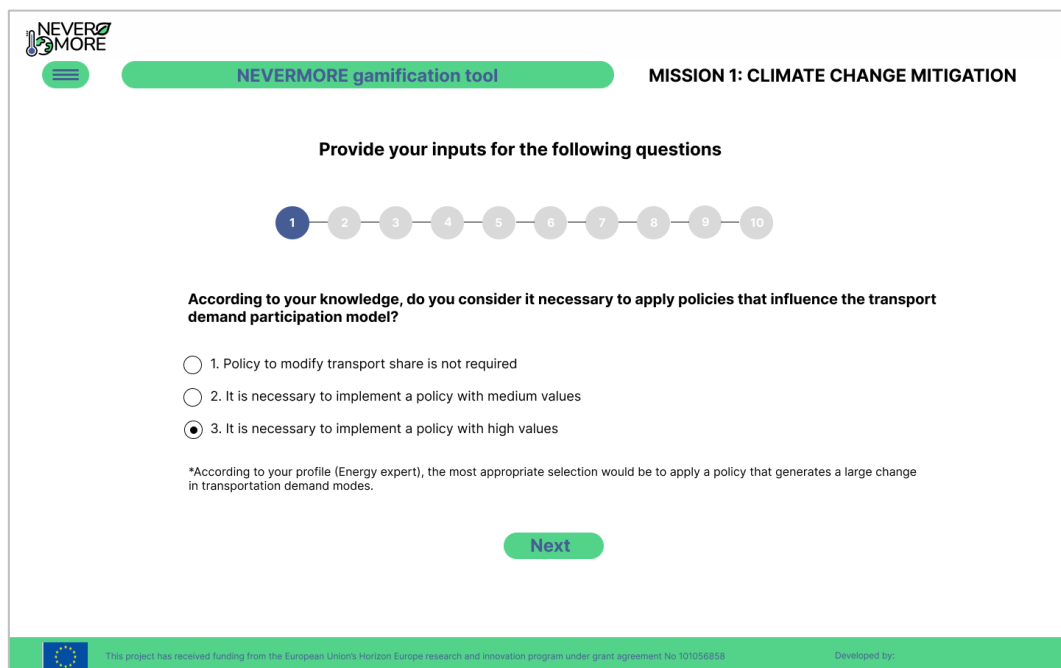


Figure 43: Interface for policy parametrization.

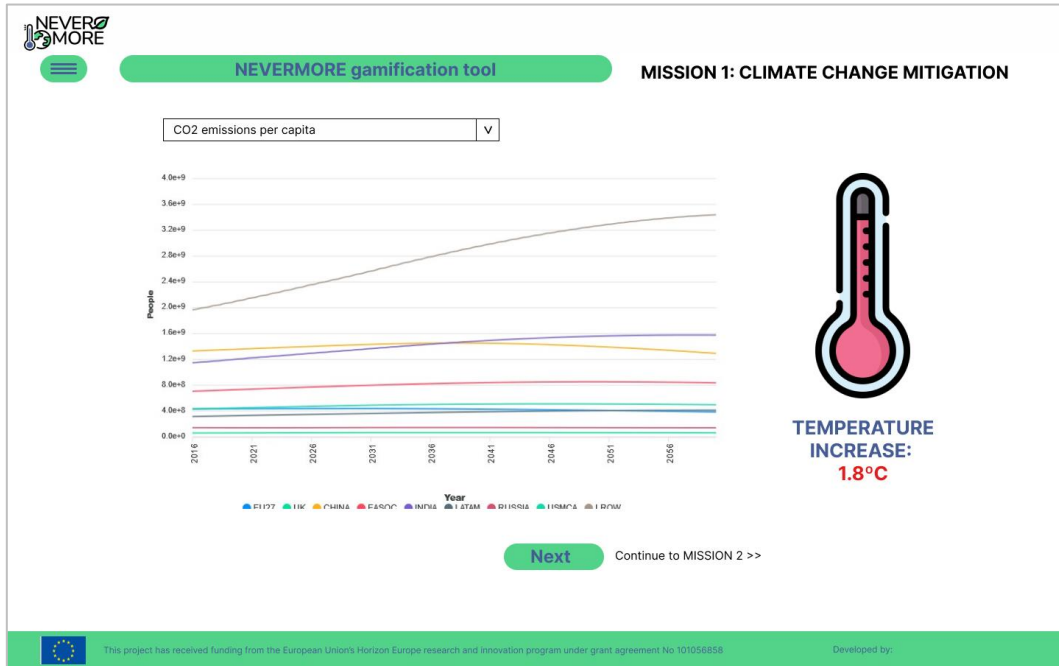


Figure 44: Interface for the mitigation results evaluation.

In the mitigation part, the user will be able to select a case study and the main hazard before starting with the policy parametrization (Figure 45). When the selection is defined, the user will be able to select the policies according to the available budget and considering the case study needs (Figure 46). This is crucial to obtain accurate results (Figure 47) but also to understand what are the main costs and benefits of adaptation policies implementation.

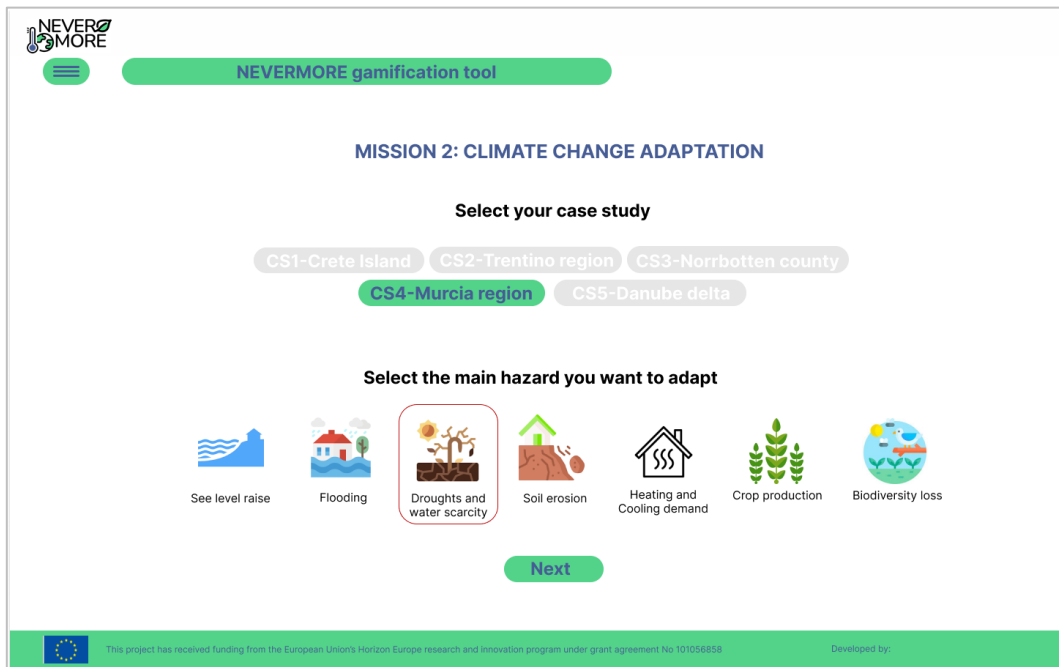


Figure 45: Interface for case study and hazard selection.

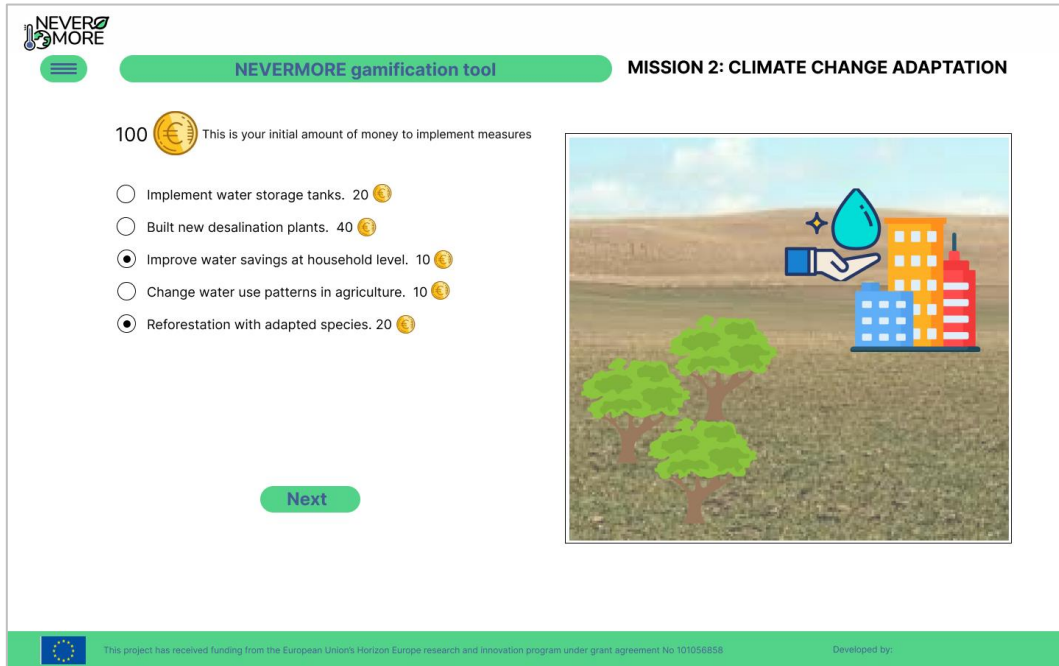


Figure 46: Interface for mitigation policies parametrization.

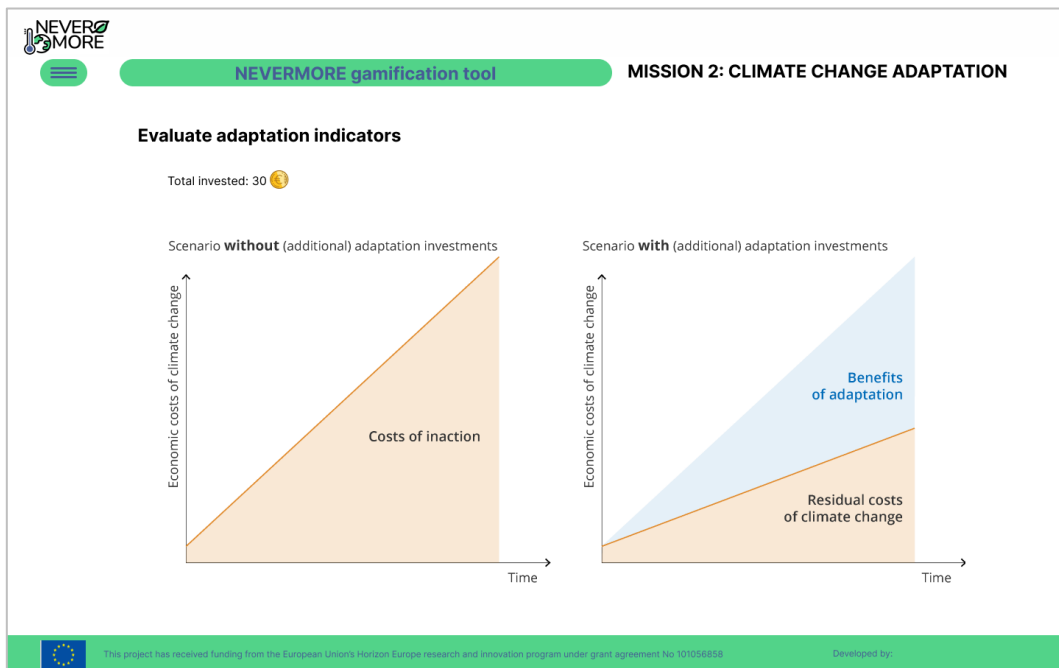


Figure 47: Interface for the visualization of the implementation of adaptation policies.

The tool will also provide an alternative use as a group player. In this option, the tool administrator will provide users with a code to select the team (Figure 48). It will be necessary to explore methods for the management of different teams in a concurrent use of the application. Mitigation policies parametrization and result evaluation will be included in the same way as it was explained for the use as an individual player (Figure 48 and Figure 49). The main novelty is the inclusion of a chat in which the user is able to interact with the other player in the same team in order to create a consensus in the selected policies as a previous step of the results evaluation.

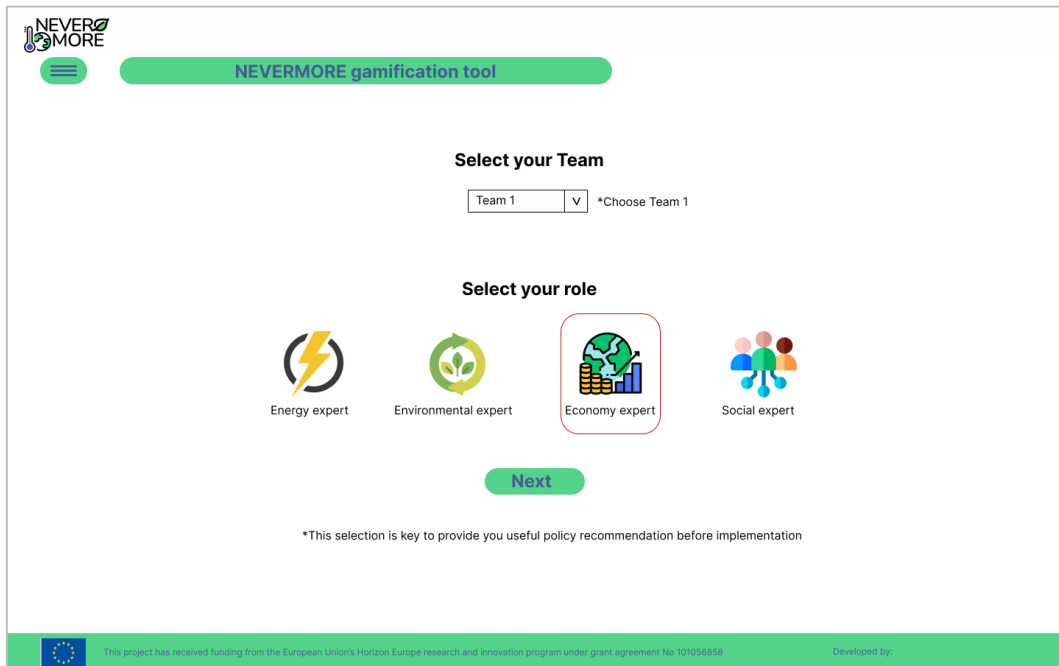


Figure 48: Interface for role selection as a team player.

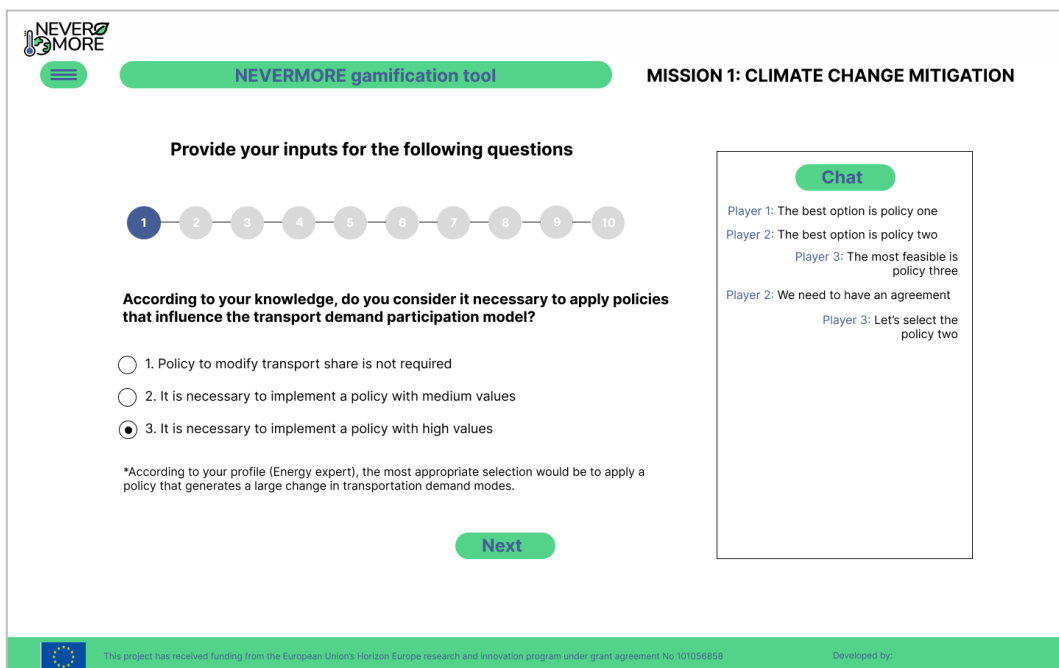


Figure 49: Interface for policy parametrization as team player.

The mitigation results will be presented following the same structure as in the interface for the individual users (Figure 50). After that, a new interface will be created in order to provide user with a comparison of the results between groups (Figure 51) considering the mitigation policies agreed in the previous steps. It is also necessary to reflect that the results of the mitigation are crucial in order to obtain the adaptation pathway based on the temperature change.

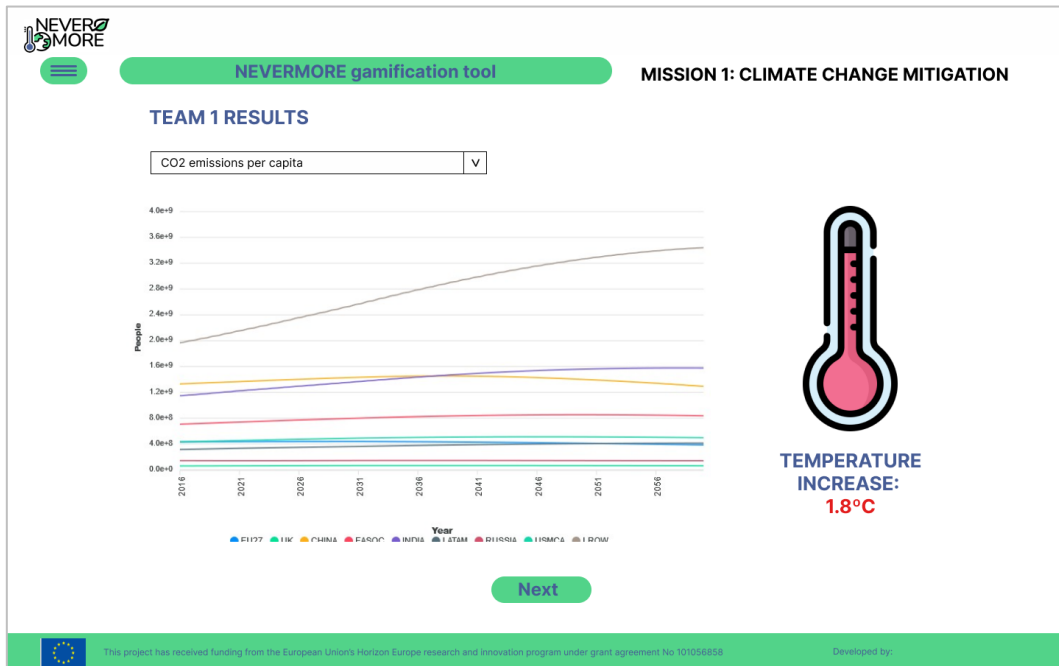


Figure 50: Interface for the mitigation results evaluation as a team player.

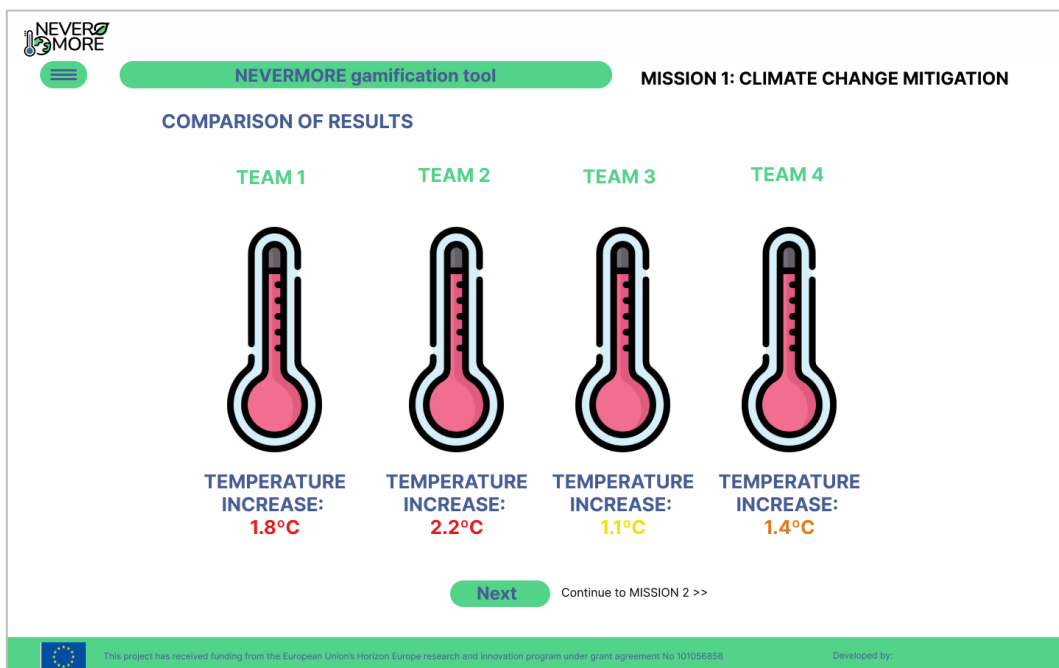


Figure 51: Interface for results comparison as a team player.

In the mitigation part, the user will be able to select a case study and the main hazard before starting with the policy parametrization in a same way as in the interface for individual (Figure 52). When the selection is defined, the user will be able to select the policies according to the available budget and considering the case study needs. As in the mitigation step a chat will be available to create consensus in the adaptation policy selection (Figure 53). It is necessary to consider that the role selection in the initial steps of the tool will be use during the case study and hazard selection providing recommendations and guidelines for the users about the selection.



Figure 52: Interface for case study and hazard selection as a team player.

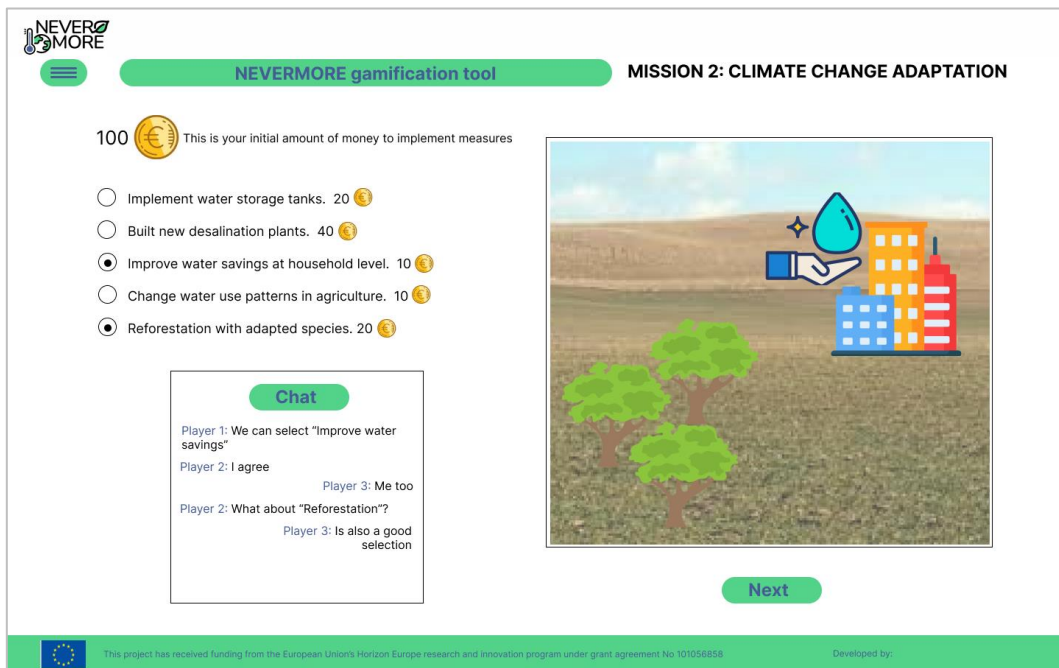


Figure 53: Interface for mitigation policies parametrization as a team player.

Finally, the tool will include an interface to compare the results for the teams in order to obtain the winner of the game (Figure 54). Medals will be included to rank the teams according to the success of adaptation policy implementation. This interface will be the end of the game.



Figure 54: Interface for results comparison in adaptation as a team player.

9.5. Architecture

In this section, the initial architecture for the implementation of the Gamification tool is presented based on a client-server architecture. In addition, some technologies are proposed before starting with the development steps.

9.5.1. Selected Technologies

The frontend is proposed to be implemented with Angular technology, combining the HTML and CSS views with the logic and communication with the backend using TypeScript. Apart from the components to create a monolithic application in the frontend, libraries such as chart.js could be used for the graphical representation of the results. Other alternatives will be analysed during the implementation steps in order to ensure results exportation. For the backend, the proposal is aligned with the previous tool and FastAPI could be the most suitable alternative in order to define the API communication with the frontend. The information will be stored in a PostgreSQL database making easy the data collection for the visualization. Postman is proposed for backend testing activities.

9.5.2. Tool Architecture

The system could be implemented following a client-server architecture as shown in Figure 55. This architecture is very close to the proposal for the other NEVERMORE tools. This architecture will be expanded to integrate specificities in order to cover the requirements for the implementation as a web-based and mobile application.

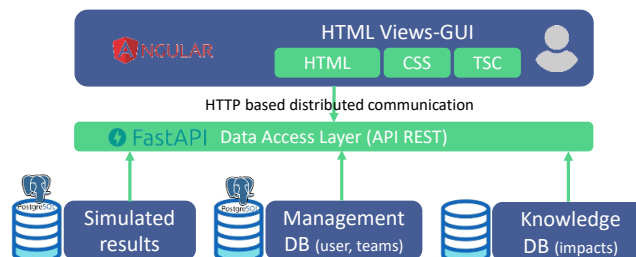


Figure 55. Monolithic architecture of the Gamification tool.

10. Design validation with project partners

To conclude the development of the initial version of the tools that will make up NEVERMORE's ICT toolkit, the design has been shared with the other project partners who are not part of Task 7.1. This approach aims to involve all partners in the project tools development. These activities will be complemented by a presentation of the tools to the Local Councils of Stakeholders in the five Case Studies to refine the initial concept before proceeding to development in Task 7.3. During this task, consultation processes will gather opinions from external project experts, ensuring the needs of potential end users are considered in developing practical activities for their daily use.

To gather opinions from the project partners (including Case Study Leaders as potential end-users) four different Jamboards (one per tool) have been created. Each partner could contribute with their ideas and needs, considering the design (mock-up), as well as the general explanation of the use case and the necessary workflow for using the tool. Subsequently, the results and conclusions for Case study tool, A&M catalogue and Gamification tool will be presented. The EU-scale tool is not reported in the following section because there were no comments in its Jamboard.

10.1. Case study tool

In this section, the inputs provided to improve the case study tool are included. Figure 56, presents some screenshots of the Jamboard where the improvements were collected. Inputs from Case Study Leaders PAT, FBK, EKNorr, INFO and NCSRd were analysed to extract useful recommendation to improve the design.

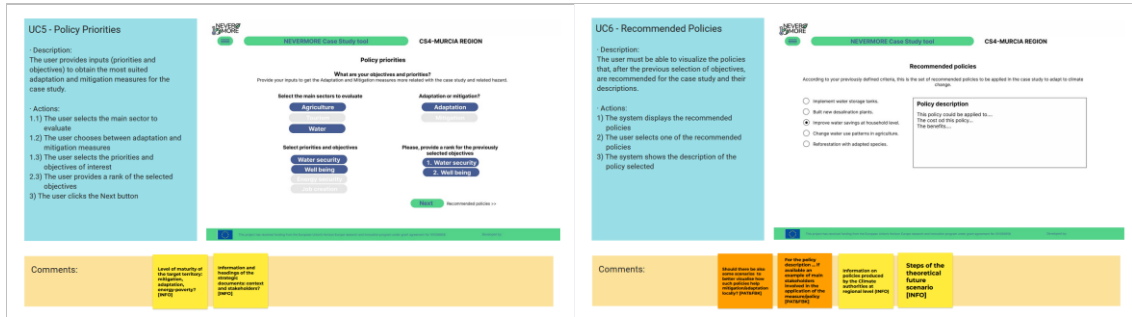


Figure 56. Collected inputs for the Case Study tool.

General tool explanation

- To better understand the wireframe and the functionalities, it would be helpful to clarify that the tool will be uploaded on the project website and if general information of the tool will be provided before.

Case study selection

- Visualizing Case Studies on an EU map would be useful.
- Agree, map would be even better.

Evaluation of Case Study data

- Provide some general and brief information on the Case Studies in the interface and then a link for "more information".
- Provide an overview on what the user will see in the following pages, because just the "next"-button does not show how many more pages there will be.
- Showing maps with priority sectors would be good for the interface.
- Explain what the challenges in this section are. If they are considered as climate hazards or risks.

ECVs/Hazard Assessment

- Clarify if the hazards that will be represented are the 2-3 most important hazards identified in Task 6.2.
- Allow the users (particularly if policymakers are tool targets) to download graphs (png).
- Allow the users (particularly if policymakers are tool targets) to have a very communicative explanation of what the graph presents and on the data information and update.
- Clarify if there will be a button/section where data can be downloaded.
- Clearly indicate what is not relevant for selected case study.
- Clarify if the dashboard will be static or dynamic.

Assets/Vulnerability/Risk visualization

- Indicate if there will be a button/section where data/layers/.png can be downloaded.
- Define if the features in this interface are dependent on coordinates from the case studies, and determine how to deal with lack of coordinates in case they could not be provided for certain specific assets.
- Check if the last outcome in this interface is risk or exposure to risk.
- Explaining what is meant with vulnerability is critical.

Vulnerability/Risk Sectoral Comparison

- In consultation all evaluated assets/vulnerable elements were related to the focus sectors (e.g. mainly tourism, energy, etc.); therefore, the radar chart could be "sided" on that sector.

- Allow the users (in particular if policymakers are the tool target) to have a very communicative explanation of what the graphs present.
- Clarify if the sectors will be different for different case studies.
- Some ranking in the interface could be actual ranking.

Policy Priorities

- Provide level of maturity of the target territory: mitigation, adaptation, energy-poverty.
- Provide information and headings of the strategic documents: context and stakeholders.

Recommended Policies

- Clarify if there should be also some scenarios to better visualise how such policies help mitigation/adaptation locally.
- Provide for the policy description an example, if available, of the main stakeholders involved in the application of the measure/policy.
- Provide information on policies produced by the Climate authorities at regional level.
- Display steps of the theoretical future scenario.

Considering the inputs, it is necessary to include clearer explanations on the concepts that we are using in the tool. Downloading is key for all the partner in order to have data to implement their own evaluations. It is also necessary to clarify what information is applicable to each case study and also the step in which you are according to the general assessment steps that are part of the tool. The most critical aspect is related on how the tool is able to provide assessment of future scenarios. It is necessary to have a better knowledge on the methods at case study level before considering this functionalities in the tool at local level.

Considering that the tool will be part of an ICT toolkit and available on the project website, the main concern is related on how to adapt the information on the knowledge level of the final end-users. A deep analysis will be necessary in Task 7.3 to clarify this aspect. We also need to research more on how to present the changes, vulnerabilities and risks in order to create a more dynamic interface that cover the end-user need providing a user-friendly and easy-to-use interface that could be applicable to evaluate different and complex case studies.

10.2. A&M catalogue

This section provides the inputs from NCSR (Supporter for the Sitia Case Study) to improve the A&M catalogue tool. The screenshots of the Jamboard including the collected comments are displayed in Figure 57. Collected inputs for the A&M catalogue tool. Then, the provided inputs were analysed to extract useful recommendation to enhance the design.

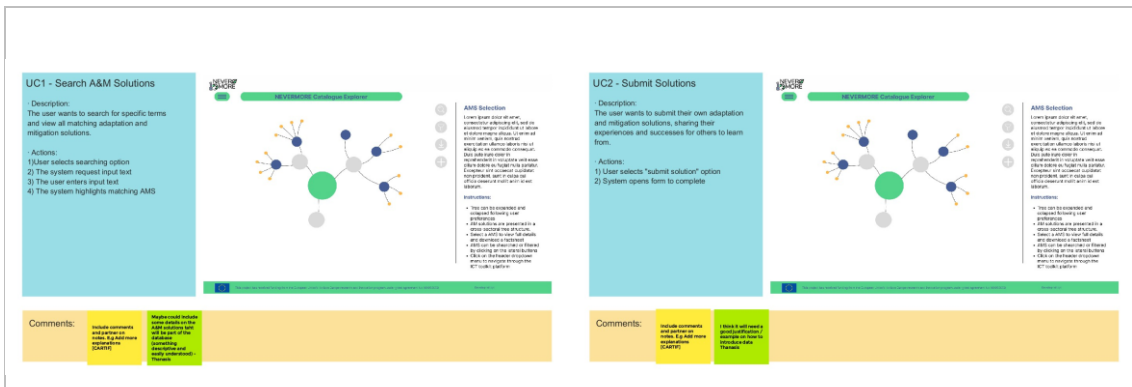


Figure 57. Collected inputs for the A&M catalogue tool.

Search A&M Solutions

- Include some details on the A&M solutions that will be part of the database (something descriptive and easy to understand).

Submit Solutions

- Provide a justification/example on how to introduce data.

Considering the inputs, it is necessary to comprise more information on the A&M solutions (e.g. a brief description) in the Search A&M Solutions section, so that the users could make conscious choices when selecting the measures to apply. Another critical point is the submissions of the users' solutions. Therefore, it is necessary to include a better guidance for the introduction of the users' data in the tool.

In Task 7.3, all the above recommendations will be described more in detail and will be implemented to obtain a more user-friendly and easier to use interface.

10.3. Gamification tool

The inputs on the gamification tool provided by PAT and FBK (respectively Case Study Leader and Supporter for Trentino Case Study) are reported in this section. In Figure 58. Collected inputs for the Gamification tool., the screenshots of the Jamboard with the collected improvements are presented. The comments were analysed to extract useful recommendation to improve the design.

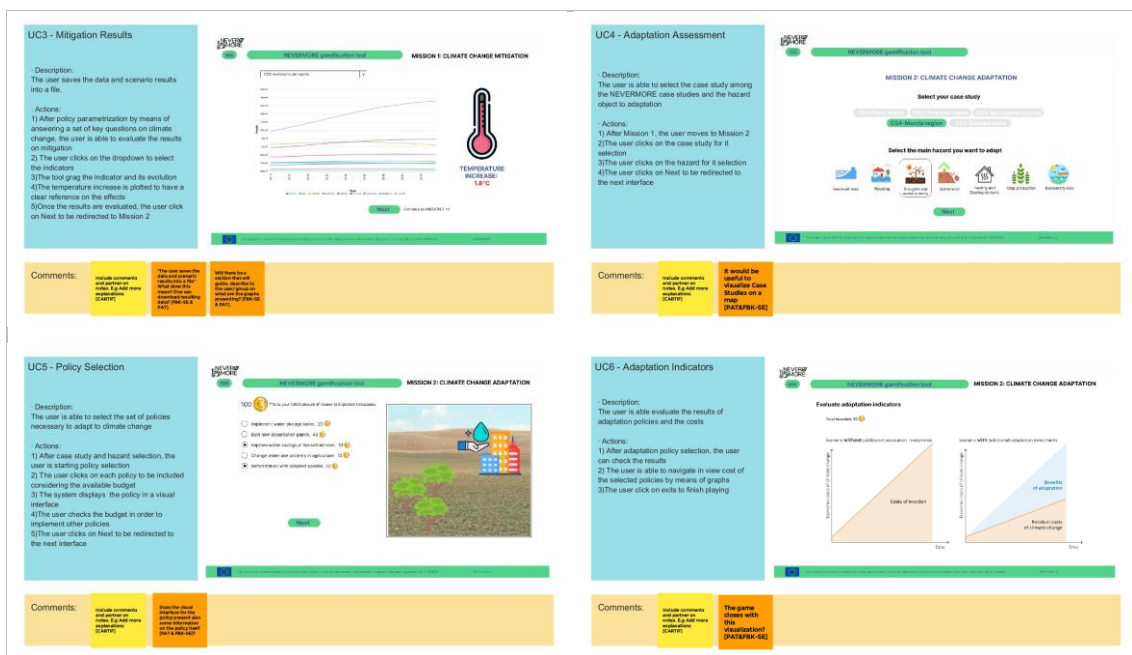


Figure 58. Collected inputs for the Gamification tool.

Mitigation Results

- Clarify what it means that the users can save the data and scenario results into a file and if they can download the resulting data.
- Provide a section that will guide and describe the displayed graphs to the user/group.

Adaptation Assessment

- Visualizing Case Studies on a map would be useful.

Policy Selection

- Clarify if the visual interface for the policy present also some information on the policy itself.

Adaptation Indicators

- Clarify if the game finishes with the visualization in the interface.

The inputs provided by FBK and PAT highlighted that it is necessary to include clearer guidance on how to save the outcomes from the tool (data and scenarios). The downloading feature is also an important characteristic, which needs clarification on the steps to perform it and on the data that can be downloaded. Moreover, the partners considered that a descriptive section is needed to explain the graphs displaying the results in the Mitigation Results section of the tool. Regarding the selection of the case study of interest in the Adaptation Assessment interface, it is convenient to introduce a map where the location of the case studies is highlighted. This adjustment, together with a better visualization of the adaptation indicators, would make the interface more user-friendly which is a key feature for the Gamification tool. Another necessary improvement is the visualization of easily understandable policy information in the Policy Selection interface allowing the users to make a more informed choice.

All these suggestions and the related improvements will be clarified in Task 7.3, in which the ICT toolkit is going to be developed after enhancing its design.

11. Conclusions

This report presents the activities developed in the context of Task 7.1 “Design of the common ICT toolkit architecture” for designing the overall ICT toolkit on NEVERMORE, including its architecture and tools specification. The definition starts with the concept of all the tools will require a common access and will be integrated as services in the general ICT toolkit of NEVERMORE. The toolkit will include four different tools: A&M catalogue, Case Study tool, EU-Scale tool and the Gamification tool.

With this idea in mind, the overall concept of the toolkit was defined in the initial part of this document, providing the integration framework for the tool’s deployment. These tools, will be target to different end-users which conditioned and oriented the decisions for the design activities. Collected requirements from WP2 activities were key to identify the main functionalities of each tool that are represented in specific use cases connected with the mock-ups that represent the visual concept of each tool. This visual appearance, includes the location in the interface of all the components that will be ready to interact with the data or the visualization (e.g. graphs, selectors indicators, etc.).

Despite this document defining the initial steps for implementing the tools that will constitute the NEVERMORE ICT toolkit, it will be necessary to continue working to refine and/or adapt the concept of each tool to the data it will work with and the specific needs of the user. Therefore, the next steps should define the data that each tool will use, the model or work package (WP) that produces this data, its format, and its integration into the workflow of the tool. With this knowledge, it will be easier to make progress in improving the design and code implementation to obtain accurate and functional tools. This will be done in the context of the following tasks of WP7: Task 7.3 “Design and development of the different ICT solutions” and Task 7.4. “Development of the frontend for the different ICT solutions”.

Finally, it is important to highlight the role that stakeholders and case studies will play in the development of the tools. As end users, they will be involved in testing and validating the developments to gather feedback, improvements, and errors, ensuring that the tools are tested and validated to meet their needs. This will enable them to contribute to decision-making and climate awareness by enhancing understanding of the effects of climate change, as well as the solutions that can be implemented to increase the climate resilience of the territory and population.

12. References

- Capellán-Pérez, I., Álvarez-Antelo, D., & Miguel, L. (2019). Global Sustainability Crossroads: A Participatory Simulation Game to Educate in the Energy and Sustainability Challenges of the 21st Century. *Sustainability*, 23.
- Chan, T., & Leung, A. (2020). Illuminate: A Simulation Game to Instill Grounded Hope in Youth for Climate Action. (págs. 47-49). CHI PLAY '20: Extended Abstracts of the 2020 Annual Symposium on Computer-Human Interaction in Play.
- Ramos, I., Miguel, F., Delgado, R., Pérez, M. S., Escudero, D., & Crespo, Y. (2023). *Decision-making, gamification and awareness tools*. LOCOMOTION project.

13. Annexes

In the annexes, the use cases that describe the functionalities of each of the tools are described in detail along with the use cases that have been implemented to describe the integration framework that would make up the ICT toolkit.

13.1. Annex I: ICT Toolkit General Use Cases

This Annex I describes in detail the use cases developed to cover the integration framework (ICT Toolkit) functionalities

Table 20. ICT toolkit: UC1, Register as a tool user.

| Use case | | UC1 - Register as tool user |
|-------------------------|--------------|--|
| Identifier | | Register |
| Description | | The user wants to register as a user of the tool |
| Actors | | All unlogged users |
| Inputs | | User registration details |
| Outputs | | User account |
| Tools | | General interface |
| Preconditions | | The system has recognized the user as an unlogged user User does not have an existing account |
| Normal sequence | Step | Action |
| | 1 | User enters registration details. |
| | 2 | The tool validates the registration information. |
| | 3 | User account is created. |
| Post condition | | User has a registered account. |
| Exception | Step | Action |
| | (1-2) | Registration information is invalid or incomplete. |
| | (1-2) | User cancels registration sequence ending use case without any postcondition |
| Linked Use Cases | | Log into the tool, Recover password |
| Importance | | High |
| Urgency | | High |
| Comments | | - |

Table 21. ICT toolkit: UC2, Log into the tool.

| Use case | | UC2- Log into the tool |
|------------------------|-------------|---|
| Identifier | | LogIn |
| Description | | The user wants to log into the tool using their credentials |
| Actors | | All unlogged users |
| Inputs | | User login credentials |
| Outputs | | User session |
| Tools | | General interface |
| Preconditions | | The system has recognized the user as an unlogged user User have an existing account |
| Normal sequence | Step | Action |
| | 1 | User enters login credentials. |
| | 2 | The system verifies login credentials |

| | | |
|-------------------------|--------------|---|
| | 3 | User session is initiated |
| Post condition | | User is logged into the tool. |
| Exception | Step | Action |
| | (1-2) | login credentials are invalid or incomplete. |
| | (1-2) | User cancels login sequence ending use case without any postcondition |
| Linked Use Cases | | Log into the tool, Recover password |
| Importance | | High |
| Urgency | | High |
| Comments | | - |

Table 22. ICT toolkit: UC3, Recover password.

| | | |
|-------------------------|--|---|
| Use case | UC3 - Recover password | |
| Identifier | RecoverPassword | |
| Description | The user wants to recover their forgotten password | |
| Actors | All logged users | |
| Inputs | User email address | |
| Outputs | Password reset instructions | |
| Tools | General interface | |
| Preconditions | User has a registered account | |
| Normal sequence | Step | Action |
| | 1 | User requests password recovery. |
| | 2 | User enters requested information |
| | 3 | The tool sends password reset instructions to the user's email address. |
| | 4 | User follows the instructions to reset the password. |
| Post condition | User successfully resets their password. | |
| Exception | Step | Action |
| | (1-3) | Requested information is invalid or account does not exist |
| | (1-3) | User cancels sequence ending use case without any postcondition |
| Linked Use Cases | Register as tool user, Log into the tool | |
| Importance | Medium | |
| Urgency | Medium | |
| Comments | - | |

Table 23. ICT toolkit: UC4, Tool selection.

| | | |
|----------------------|---|---------------|
| Use case | UC4 – Tool selection | |
| Identifier | Tselection | |
| Description | The user is able to select the tool before starting an analysis | |
| Actors | All unlogged users | |
| Inputs | User registration details | |
| Outputs | User account | |
| Tools | General interface | |
| Preconditions | The system has recognized the user as an unlogged user | |
| | User does not have an existing account | |
| | Step | Action |

| | | |
|------------------|---|--|
| Normal sequence | 1 | User navigate in the main interface |
| | 2 | The user selects the tool to work with |
| | 3 | The user is redirected to the tool main interface |
| Post condition | User has the opportunity to test the tool | |
| Exception | Step | Action |
| | (1-2) | Registration information is invalid or incomplete. |
| | (1-2) | User cancels registration sequence ending use case without any postcondition |
| Linked Use Cases | Log into the tool | |
| Importance | High | |
| Urgency | High | |
| Comments | - | |

13.2. Annex II: A&M Catalogue Tool Use Cases

Annex II describes in detail the use cases developed to cover the A&M catalogue tool functionalities.

Table 24. A&M catalogue: UC0, Assessment using the tool.

| Use case | UC0 - Assessment using the tool | |
|------------------|---|--|
| Identifier | Assessment | |
| Description | The user wants to perform an assessment using the tool to learn platform features | |
| Actors | All users | |
| Inputs | None | |
| Outputs | Assessment | |
| Tools | General interface, A&M Catalogue Tool | |
| Preconditions | The system has recognized the user as a logged or unlogged user | |
| | The user has accessed the A&M Catalogue tool | |
| Normal sequence | Step | Action |
| | 1 | User enters the A&M Catalogue Tool |
| | 2 | The tool performs the assessment |
| Post condition | User obtains assessment results and recommendations | |
| Exception | Step | Action |
| | 2 | The user can cancel the assessment tutorial ending the use case without any post condition |
| Linked Use Cases | None | |
| Importance | Medium | |
| Urgency | Medium | |
| Comments | None | |

Table 25. A&M catalogue: UC1, Search A&M Solutions.

| Use case | UC1 - Search A&M Solutions | |
|-------------|--|--|
| Identifier | SearchSolution | |
| Description | The user wants to search for specific terms and view all matching adaptation and mitigation solutions. | |
| Actors | All users | |
| Inputs | Text | |
| Outputs | Highlight matching AMS | |

| | | |
|-------------------------|--------------|---|
| Tools | | A&M Catalogue tool |
| Preconditions | | The system has recognized the user as a logged or unlogged user The user has accessed the A&M Catalogue tool |
| Normal sequence | Step | Action |
| | 1 | User selects searching option |
| | 2 | The system request input text |
| | 3 | The user enters input text |
| | 4 | The system highlights matching AMS |
| Post condition | | Matching AMS are highlighted |
| Exception | Step | Action |
| | (1-3) | The User can cancel the search ending the use case without any post condition |
| | 4 | There are not AMS matching search terms |
| Linked Use Cases | | Select AMS |
| Importance | | Medium |
| Urgency | | Medium |
| Comments | | - |

Table 26. A&M catalogue: UC2, Submit Solution.

| | | |
|-------------------------|--------------|---|
| Use case | | UC2 - Submit Solution |
| Identifier | | SubmitSolution |
| Description | | The user wants to submit their own adaptation and mitigation solutions, sharing their experiences and successes for others to learn from. |
| Actors | | All logged users |
| Inputs | | - |
| Outputs | | - |
| Tools | | A&M Catalogue tool |
| Preconditions | | The system has recognized the user as a logged user The user has accessed the A&M Catalogue tool |
| Normal sequence | Step | Action |
| | 1 | User selects "submit solution" option |
| | 2 | System opens form to complete |
| Post condition | | A form is showed to user to be completed |
| Exception | Step | Action |
| | (1-2) | The User can cancel the search ending the use case without any post condition |
| Linked Use Cases | | None |
| Importance | | Medium |
| Urgency | | Medium |
| Comments | | - |

Table 27. A&M catalogue: UC3, Navigate Cross-Sectoral Policies.

| | | |
|--------------------|--|---|
| Use case | | UC3 - Navigate Cross-Sectoral Policies |
| Identifier | | NavigateSectors |
| Description | | The user wants to access high-level cross-sectoral policies to gain a comprehensive view of climate adaptation and mitigation measures. The user wants to access information in a progressive manner, starting from high-level overviews and gradually accessing more detailed technical information. |

| | | |
|-------------------------|---|--|
| Actors | All users | |
| Inputs | - | |
| Outputs | Information displayed changes | |
| Tools | A&M Catalogue Tool | |
| Preconditions | The system has recognized the user as a logged or unlogged user | |
| | The user has accessed the A&M Catalogue tool | |
| Normal sequence | Step | Action |
| | 1.a | User selects the option to expand cross-sectoral policies. |
| | 1.b | User selects the option to collapse cross-sectoral policies. |
| | 2.a | The tool presents high-level overviews of cross-sectoral policies. |
| | 2.b | The tool presents low-level overviews of cross-sectoral policies. |
| Post condition | User gains a comprehensive view of cross-sectoral policies. | |
| Exception | Step | Action |
| | 1 | None |
| Linked Use Cases | None | |
| Importance | Medium | |
| Urgency | Medium | |
| Comments | - | |

Table 28. A&M catalogue: UC4, Select AMS.

| | | |
|-------------------------|--|---|
| Use case | UC4- Select AMS | |
| Identifier | SelectAMS | |
| Description | The user wants to analyze measures based on relevant criteria by utilizing the system's categorization. The user wants to analyze and assess the synergies, trade-offs, potential impacts, scale dimension, effectiveness type of policy, sector, location (including climate and population density). The user wants to access information about how each measure can be financed, the success of each measure in other geographical areas, impact and outcomes. The user wants to access information and recommendations on how policies can be implemented and adapted to specific territorial areas. | |
| Actors | All users | |
| Inputs | User-selected criteria | |
| Outputs | Analyzed measure and associated information | |
| Tools | A&M Catalogue Tool | |
| Preconditions | The system has recognized the user as a logged or unlogged user | |
| | The user has accessed the A&M Catalogue tool | |
| Normal sequence | Step | Action |
| | 1 | User selects desired filters |
| | 2 | User selects desired AMS |
| | 3 | The system displays AMS related information an analisis |
| Post condition | User obtains analyzed measures and relevant information based on the selected criteria. | |
| Exception | Step | Action |
| | (1-3) | User selects diferent criteria, AMS or unselects AMS |
| Linked Use Cases | Download factsheet, go to Local tool, go to Global tool | |
| Importance | High | |
| Urgency | High | |

| | |
|----------|---|
| Comments | - |
|----------|---|

Table 29. A&M catalogue: UC5, Download Factsheet.

| Use case | | UC5 - Download Factsheet |
|-------------------------|-------------|---|
| Identifier | | DownloadFactsheet |
| Description | | The user wants to download a factsheet or summary document for each policy, providing a concise and printable resource. |
| Actors | | All users |
| Inputs | | Selected AMS |
| Outputs | | Downloaded factsheet or summary document |
| Tools | | A&M Catalogue Tool |
| Preconditions | | The system has recognized the user as a logged or unlogged user |
| | | The user has accessed the A&M Catalogue tool |
| | | User has selected an AMS |
| Normal sequence | Step | Action |
| | 1 | User selects "download factsheet" option |
| | 2 | Factsheet is downloaded |
| Post condition | | User obtains a downloaded factsheet or summary document for the selected policy. |
| Exception | Step | Action |
| | 1 | None |
| Linked Use Cases | | Select AMS |
| Importance | | Medium |
| Urgency | | Medium |
| Comments | | - |

Table 30. A&M catalogue: UC6, Related AMS to challenges.

| Use case | | UC6 - Related AMS to challenges |
|-------------------------|-------------|--|
| Identifier | | RelatedChallenges |
| Description | | The user wants to understand the general challenges and considerations related to policies and solutions by connecting each measure to them. |
| Actors | | All users |
| Inputs | | Challenge |
| Outputs | | Related AMS to selected challenge |
| Tools | | A&M Catalogue Tool |
| Preconditions | | The system has recognized the user as a logged or unlogged user |
| | | The user has accessed the A&M Catalogue tool |
| Normal sequence | Step | Action |
| | 1 | User selects a challenge |
| | 2 | System shows all AMS related to that challenge |
| Exception | Step | Action |
| | 1 | None |
| Linked Use Cases | | Select AMS |
| Importance | | Medium |
| Urgency | | Medium |
| Comments | | - |

Table 31. A&M catalogue: UC7, Filter by Geographic and Climatic Areas.

| Use case | | UC7 - Filter by Geographic and Climatic Areas |
|-------------------------|-------------|---|
| Identifier | | GeographicFiltering |
| Description | | The user wants to filter and search for policies based on geographical and climatic areas of application, ensuring relevance and suitability. |
| Actors | | All users |
| Inputs | | Geographic and climatic areas |
| Outputs | | Matching AMS |
| Tools | | A&M Catalogue Tool |
| Preconditions | | The system has recognized the user as a logged or unlogged user The user has accessed the A&M Catalogue tool |
| Normal sequence | Step | Action |
| | 1 | User enters desired climatic or geographical area |
| | 2 | System displays matching AMS |
| Exception | Step | Action |
| | 1 | None |
| Linked Use Cases | | Select AMS |
| Importance | | Medium |
| Urgency | | Medium |
| Comments | | - |

Table 32. A&M catalogue: UC8, Filter by Implemented Policies.

| Use case | | UC8 - Filter by Implemented Policies |
|-------------------------|-------------|---|
| Identifier | | ImplementedPoliciesFiltering |
| Description | | The user wants to filter by policies that have already been implemented in other areas, learning from successful practices. |
| Actors | | All users |
| Inputs | | None |
| Outputs | | Matching AMS |
| Tools | | A&M Catalogue Tool |
| Preconditions | | The system has recognized the user as a logged or unlogged user The user has accessed the A&M Catalogue tool |
| Normal sequence | Step | Action |
| | 1 | User activates filter |
| | 2 | System displays matching AMS |
| Exception | Step | Action |
| | 1 | None |
| Linked Use Cases | | Select AMS |
| Importance | | Medium |
| Urgency | | Medium |
| Comments | | - |

Table 33. A&M catalogue: UC9, Navigate to global tool.

| Use case | | UC9 - Navigate to global tool |
|------------------|------|---|
| Identifier | | NavigateGlobalTool |
| Description | | User wants to access global tool features related to selected AMS |
| Actors | | All users |
| Inputs | | selected AMS |
| Outputs | | Global tool interface |
| Tools | | A&M Catalogue Tool |
| Preconditions | | The system has recognized the user as a logged or unlogged user |
| | | The user has accessed the A&M Catalogue tool |
| | | The user has selected an AMS |
| Normal sequence | Step | Action |
| | 1 | User selects option go to "related Global Tool" |
| | 2 | System opens Global tool interface |
| Post condition | | Global tool interface with related features is displayed |
| Exception | Step | Action |
| | 1 | None |
| Linked Use Cases | | Select AMS |
| Importance | | Medium |
| Urgency | | Medium |
| Comments | | - |

Table 34. A&M catalogue: UC10, Navigate to local tool.

| Use case | | UC10 - Navigate to local tool |
|------------------|------|---|
| Identifier | | NavigateLocalTool |
| Description | | User wants to acces Local tool features related to selected AMS |
| Actors | | All users |
| Inputs | | selected AMS |
| Outputs | | Local tool interface |
| Tools | | A&M Catalogue Tool |
| Preconditions | | The system has recognized the user as a logged or unlogged user |
| | | The user has accessed the A&M Catalogue tool |
| | | The user has selected an AMS |
| Normal sequence | Step | Action |
| | 1 | User selects option go to "related Local Tool" |
| | 2 | System opens Local tool interface |
| Post condition | | Local tool interface with related features is displayed |
| Exception | Step | Action |
| | 1 | None |
| Linked Use Cases | | Select AMS |
| Importance | | Medium |
| Urgency | | Medium |
| Comments | | - |

13.3. Annex III: Case Study Tool Use Cases

Annex III describes in detail the use cases developed to cover the Case study tool functionalities.

Table 35. Case study tool: UC0, Case Study Selection.

| Use case | | UC0 – Case Study Selection |
|-------------------------|-------------|---|
| Identifier | | CSSelection |
| Description | | The user selects the case study (from NEVERMORE) to be assessed by the tool. |
| Actors | | All registered users |
| Inputs | | User-selected case study |
| Outputs | | Case study is selected for the next steps |
| Tools | | Case Study tool |
| Preconditions | | The user is registered |
| | | The user has accessed the Case Study tool |
| Normal sequence | Step | Action |
| | 1 | The user selects the case study to assess |
| | 2 | The user clicks the Next button |
| Post condition | | The user has access for the evaluation of case study data |
| Exception | Step | Action |
| | 1 | The system crashes cancelling the steps done and returning to the log-in page |
| Linked Use Cases | | UC1 - Evaluation of Case Study Data |
| Importance | | High |
| Urgency | | High |
| Comments | | - |

Table 36. Case study tool: UC1, Evaluation of Case Study Data.

| Use case | | UC1 – Case Study Selection |
|------------------------|-------------|--|
| Identifier | | DataEvaluation |
| Description | | The user wants to uncover a general description of the case study selected and its relevant information about priority sectors and main challenges |
| Actors | | All registered users |
| Inputs | | User-selected sector of the case study |
| | | User-selected challenge of the case study can be reviewed |
| Outputs | | Description on the case study feasible to be evaluated |
| | | Information on sector selected |
| | | Information on challenge selected and visualized |
| Tools | | Case Study tool |
| Preconditions | | The user is registered |
| | | The user has accessed the Case Study tool |
| | | The user has selected a case study |
| Normal sequence | Step | Action |
| | 1 | The user clicks the More information link |
| | 1.1 | The system displays a general description of the case study |
| | 2 | The user selects one of the priority sectors |
| | 2.1 | The system shows relevant information regarding the sector selected |

| | | |
|-------------------------|-------------|---|
| | 3 | The user selects one of the main challenges |
| | 3.1 | The system presents relevant information regarding the challenge selected |
| | 4 | The user clicks the Next button |
| Post condition | | The user is redirected to ECVs and hazard assessment |
| Exception | Step | Action |
| | All | The system crashes cancelling the steps done and returning to the log-in page |
| Linked Use Cases | | UC0 - Case Study Selection, UC2 - ECVs/Hazard Assessment |
| Importance | | Medium |
| Urgency | | Medium |
| Comments | | - |

Table 37. Case study tool: UC2, ECVs and hazard assessment.

| | | |
|-------------------------|---|---|
| Use case | UC2 – ECVs/Hazard Assessment | |
| Identifier | Assessment | |
| Description | The user wants to visualize ECVs through graphs and discover information on main hazards in the selected case study | |
| Actors | All registered users | |
| Inputs | User-selected ECV | |
| | User-selected hazard | |
| Outputs | Visualization of ECV selected | |
| | Information on hazard selected | |
| Tools | Case Study tool | |
| Preconditions | The user is registered | |
| | The user has accessed the Case Study tool | |
| | The user has selected a case study | |
| Normal sequence | Step | Action |
| | 1 | The user selects the ECV to display |
| | 1.1 | The system shows the ECV as a graph (ECV vs time) |
| | 2 | The user clicks on one of the main hazards |
| | 2.1 | The system displays information on the hazard selected |
| 3 | The user clicks the Next button | |
| Post condition | The user has access to exploration of assets, vulnerabilities and risks | |
| Exception | Step | Action |
| | All | The system crashes cancelling the steps done and returning to the log-in page |
| | 1.1 | The graphs are not responsive |
| Linked Use Cases | UC1 - Evaluation of Case Study Data, UC3 - Assets/Vulnerability/Risk visualization | |
| Importance | Medium | |
| Urgency | Medium | |
| Comments | - | |

Table 38. Case study tool: UC3, Assets/Vulnerability/Risk visualization.

| | |
|--------------------|--|
| Use case | UC3 – Assets/Vulnerability/Risk visualization |
| Identifier | Visualization |
| Description | The user wants to visualize map of assets, vulnerabilities and risks that change based on the selection of specific sectors and hazards, and to understand the |

| | | |
|-------------------------|-------------|--|
| | | process behind the assessments through the description provided in the information box |
| Actors | | All registered users |
| Inputs | | User-selected topic (e.g. vulnerability) |
| | | User-selected sector (e.g. agriculture) |
| | | User-selected hazard (e.g. droughts) |
| Outputs | | Map of the assets, risks or vulnerabilities based on user selection |
| | | Information on assets, risks or vulnerabilities assessment selected |
| Tools | | Case Study tool |
| Preconditions | | The user is registered |
| | | The user has accessed the Case Study tool |
| | | The user has selected a case study |
| Normal sequence | Step | Action |
| | 1 | The user selects the topic, sector and hazard of interest |
| | 2 | The system displays a map based on the user selection |
| | 2.1 | The system shows a description box comprising relevant information on the topic selected |
| | 3 | The user clicks the Next button |
| Post condition | | The user is redirected to sectoral comparison of vulnerability and risks |
| Exception | Step | Action |
| | All | The system crashes cancelling the steps done and returning to the log-in page |
| | 2 | The maps are not responsive |
| Linked Use Cases | | UC2 - ECVs/Hazard Assessment, UC4 - Vulnerability/Risk Sectoral Comparison |
| Importance | | Medium |
| Urgency | | Medium |
| Comments | | - |

Table 39. Case study tool: UC4, Vulnerability/Risk Sectoral comparison.

| Use case | UC4 – Vulnerability/Risk Sectoral Comparison | |
|------------------------|--|--|
| Identifier | | Comparison |
| Description | | The user wants to visualize the comparison between different sector for both vulnerability and risk. These are displayed in a graph form and they are based on the hazard selected by the user |
| Actors | | All registered users |
| Inputs | | User-selected hazard |
| Outputs | | Two graphs representing sectoral comparison for vulnerability and risk |
| Tools | | Case Study tool |
| Preconditions | | The user is registered |
| | | The user has accessed the Case Study tool |
| | | The user has selected a case study |
| Normal sequence | Step | Action |
| | 1 | The user selects the hazard of interest |
| | 2 | The system shows two graphs about sectoral comparison for vulnerability and risk based on the hazard selected |
| | 3 | The user clicks the Next button |
| Post condition | | The user has access to policy priorities |

| | | |
|-------------------------|--|---|
| Exception | Step | Action |
| | All | The system crashes cancelling the steps done and returning to the log-in page |
| | 2 | The graphs are not responsive |
| Linked Use Cases | UC3 - Assets/Vulnerability/Risk visualization, UC5 - Policy Priorities | |
| Importance | Medium | |
| Urgency | Medium | |
| Comments | - | |

Table 40. Case study tool: UC5, Policy Priorities.

| Use case | UC5 – Policy Priorities | |
|-------------------------|--|---|
| Identifier | Priorities | |
| Description | The user provides inputs (priorities and objectives) to obtain the most suited adaptation and mitigation measures for the case study | |
| Actors | All registered users | |
| Inputs | User-selected sectors of interest | |
| | User-selected policy type (adaptation or mitigation) | |
| | User-selected priorities and objectives | |
| | User rank of the selected objectives | |
| Outputs | The policy objectives and priorities are chosen to identify the main policy recommendations for your case study (next step) | |
| Tools | Case Study tool | |
| Preconditions | The user is registered | |
| | The user has accessed the Case Study tool | |
| | The user has selected a case study | |
| Normal sequence | Step | Action |
| | 1.1 | The user selects the main sector to evaluate |
| | 1.2 | The user chooses between adaptation and mitigation measures |
| | 1.3 | The user selects the priorities and objectives of interest |
| | 2 | The user provides a rank of the selected objectives |
| | 3 | The user clicks the Next button |
| Post condition | The user is redirected to policy recommendations | |
| Exception | Step | Action |
| | All | The system crashes cancelling the steps done and returning to the log-in page |
| Linked Use Cases | UC4 - Vulnerability/Risk Sectoral Comparison, UC6 - Recommended Policies | |
| Importance | Medium | |
| Urgency | Medium | |
| Comments | - | |

Table 41. Case study tool: UC6, Recommended policies.

| Use case | UC6 – Recommended Policies | |
|--------------------|---|--|
| Identifier | Policies | |
| Description | The user must be able to visualize the policies that, after the previous selection of objectives, are recommended for the case study and their descriptions | |
| Actors | All registered users | |
| Inputs | Criteria defined in UC5 | |

| | | |
|-------------------------|---|---|
| Outputs | The recommended policies and their descriptions | |
| Tools | Case Study tool | |
| Preconditions | The user is registered | |
| | The user has accessed the Case Study tool | |
| | The user has selected a case study | |
| | The user has selected the most relevant priorities and objectives | |
| Normal sequence | Step | Action |
| | 1.1 | The system displays the recommended policies |
| | 1.2 | The user selects one of the recommended policies |
| | 1.3 | The system shows the description of the policy selected |
| Post condition | The system crashes cancelling the steps done and returning to the log-in page | |
| Exception | Step | Action |
| | All | The system crashes cancelling the steps done and returning to the log-in page |
| Linked Use Cases | UC5 - Policy Priorities | |
| Importance | Medium | |
| Urgency | Medium | |
| Comments | - | |

13.4. Annex IV: EU-Scale Tool Use Cases

Annex IV describes in detail the use cases developed to cover the EU-Scale tool functionalities.

Table 42. EU Scale tool: UC0, Assessment of the tool.

| Use case | UC0 - Assessment using the tool | |
|-------------------------|---|--|
| Identifier | Assessment | |
| Description | The user wants to perform an assessment using the tool to learn platform features | |
| Actors | All users | |
| Inputs | None | |
| Outputs | Assessment | |
| Tools | General interface, EU Scale Tool | |
| Preconditions | The system has recognized the user as a logged or unlogged user | |
| | The user has accessed the tool | |
| Normal sequence | Step | Action |
| | 1 | User enters the EU scale Tool |
| | 2 | The tool performs the assessment |
| Post condition | User obtains assessment results and recommendations | |
| Exception | Step | Action |
| | 2 | The user can cancel the assessment tutorial ending the use case without any post condition |
| Linked Use Cases | None | |
| Importance | Medium | |
| Urgency | Medium | |
| Comments | None | |

Table 43. EU Scale tool: UC1, Create new scenario.

| Use case | | UC1 - Create new scenario |
|-------------------------|-------------|---|
| Identifier | | NewScenario |
| Description | | The user selects values for the policies in order to generate a scenario |
| Actors | | All users |
| Inputs | | Sliders and selectors |
| Outputs | | The scenario pre-calculated that corresponds to the polices values |
| Tools | | EU Scale Tool |
| Preconditions | | The system has recognized the user as a logged or unlogged user The user has accessed the EU global tool |
| Normal sequence | Step | Action |
| | 1 | User selects values for the policies |
| | 2 | The user requires visualization of the result |
| | 3 | The system generates results in form of graphics |
| Post condition | | The scenario can be saved through the UC9 |
| Exception | Step | Action |
| | (1-2) | The User can cancel the operation at any time |
| | 4 | The values from the policies do not match pre-generated scenarios |
| Linked Use Cases | | UC9 |
| Importance | | Medium |
| Urgency | | Medium |
| Comments | | - |

Table 44. EU Scale tool: UC2, Scenario navigation.

| Use case | | UC2 - Navigate Created Scenario |
|-------------------------|-------------|---|
| Identifier | | NavigateScenario |
| Description | | The user wants to check the scenario resultant from the polices selection, playing with the graphics. |
| Actors | | All logged users |
| Inputs | | - |
| Outputs | | - |
| Tools | | EU Global tool |
| Preconditions | | The system has recognized the user as a logged user The user has generated a scenario |
| Normal sequence | Step | Action |
| | 1 | User selects elements in graphics. |
| | 2 | System changes visualization in graphics. |
| Post condition | | - |
| Exception | Step | Action |
| | (1-2) | The graphics are not responsive |
| Linked Use Cases | | None |
| Importance | | Medium |
| Urgency | | Medium |
| Comments | | - |

Table 45. EU Scale tool: UC3, Save scenario to file.

| Use case | | UC3 - Export scenario |
|-------------------------|-------------|---|
| Identifier | | ExportScenario |
| Description | | The user saves the data and scenario results into a file. |
| Actors | | Registered users |
| Inputs | | Data (inputs and outputs) from the scenario |
| Outputs | | File with data in normalized format |
| Tools | | EU Global tool |
| Preconditions | | The system has recognized the user as a logged or unlogged user The user selected a scenario |
| Normal sequence | Step | Action |
| | 1 | Click the export button, active in a valid scenario. |
| | 2 | The output file is ready to be downloaded |
| Post condition | | - |
| Exception | Step | Action |
| | 1 | The file fails to be generated as a download |
| Linked Use Cases | | - |
| Importance | | Medium |
| Urgency | | Medium |
| Comments | | - |

Table 46. EU Scale tool: UC4, Go back to main entrance.

| Use case | | UC4- Go back to main entrance |
|-------------------------|-------------|--|
| Identifier | | BackToMain |
| Description | | The user wants to change some values from his registration data or similar |
| Actors | | All registered users |
| Inputs | | - |
| Outputs | | Main entry screen |
| Tools | | EU Global tool |
| Preconditions | | The user is registered |
| Normal sequence | Step | Action |
| | 1 | Go back to the global app and perform action there |
| Post condition | | - |
| Exception | Step | Action |
| | 3 | Main app cannot be accessed or recovered |
| Linked Use Cases | | - |
| Importance | | Medium |
| Urgency | | Medium |
| Comments | | - |

Table 47. EU Scale tool: UC5, Visualization of model assumptions.

| Use case | | UC5 - Show model assumptions |
|--------------------|--|--|
| Identifier | | ModelAssumptions |
| Description | | The users must be able to visualize all the model parameters that are stablish in a constant value during the model simulation |

| | | |
|-------------------------|--|---|
| Actors | All users | |
| Inputs | Scenario variables stored in the data repository of the tool | |
| Outputs | Access to visualize constant variables in the simulation | |
| Tools | EU global tool | |
| Preconditions | The system has recognized the user as a logged or unlogged user | |
| Normal sequence | Step | Action |
| | 1 | The user clicks on "Model assumptions" |
| | 2 | The system displays different groups of variables |
| | 3 | The user clicks on each group and variable to check the value used for simulation |
| | 4 | The user clicks on another variable to change the visualized parameter |
| 5 | The use case ends | |
| Post condition | User obtains a downloaded factsheet or summary document for the selected policy. | |
| Exception | Step | Action |
| | 1 | None |
| Linked Use Cases | | |
| Importance | Medium | |
| Urgency | Low | |
| Comments | | |

Table 48. EU Scale tool: UC6, Saving scenarios.

| | | |
|-------------------------|--|---|
| Use case | UC6 - Save scenario | |
| Identifier | SaveScenario | |
| Description | The user wants keep the policies values selected as a scenario for future consultation | |
| Actors | All registered users | |
| Inputs | Scenario created | |
| Outputs | Scenario saved | |
| Tools | EU global tool | |
| Preconditions | The system has recognized the user as a logged or unlogged user The user has created a valid scenario | |
| Normal sequence | Step | Action |
| | 1 | User clicks save scenario |
| | 2 | System checks that the scenario data are correct and complete |
| | 3 | System saves the scenario and gets associated to the creator |
| Exception | Step | Action |
| | 1 | Scenario cannot be saved due to incorrect or missing data |
| Linked Use Cases | - | |
| Importance | Medium | |
| Urgency | Medium | |
| Comments | - | |

Table 49. EU Scale tool: UC7, Simulation scaling.

| | |
|-------------------|-------------------------------------|
| Use case | UC7- Change simulation scale |
| Identifier | SimulationScale |

| | | |
|-------------------------|-------------|--|
| Description | | The user wants to change the scale of the simulation in order the get broader or specific results |
| Actors | | All users |
| Inputs | | Geographic and climatic areas |
| Outputs | | Readjusted policies and outputs |
| Tools | | EU global tool |
| Preconditions | | The system has recognized the user as a logged or unlogged user A valid scenario has been generated |
| Normal sequence | Step | Action |
| | 1 | User enters the new simulation scale |
| | 2 | System shows the scenario at the new scale |
| Exception | Step | Action |
| | 1 | The results cannot be refitted into the new scale or don't look valid |
| Linked Use Cases | | - |
| Importance | | - |
| Urgency | | - |
| Comments | | To be evaluated |

Table 50. EU Scale tool: UC8, Scenario sharing between users.

| | | |
|-------------------------|-------------|--|
| Use case | | UC8- Share scenario |
| Identifier | | ShareScenario |
| Description | | The user wants to share one of his scenarios with other users connected. |
| Actors | | All users |
| Inputs | | Scenario simulated |
| Outputs | | Updated list of the whole scenarios shared by the connected users. |
| Tools | | EU global tool |
| Preconditions | | A valid scenario has been generated |
| Normal sequence | Step | Action |
| | 1 | User changes status of scenario to Public |
| | 2 | System makes the scenario available for other users |
| Exception | Step | Action |
| | 1 | The scenario status cannot be changed to Public |
| Linked Use Cases | | - |
| Importance | | Medium to high |
| Urgency | | High |
| Comments | | - |

Table 51. EU Scale tool: UC8, Interaction between users.

| | | |
|--------------------|--|--|
| Use case | | UC9- Interact with other users |
| Identifier | | InteractionUsers |
| Description | | The user shares messages in real time with other users |
| Actors | | All users |
| Inputs | | Input text |
| Outputs | | Users responses in the chat box |
| Tools | | EU global tool |

| | | |
|-------------------------|----------------------------------|--|
| Preconditions | The user wants to send a message | |
| Normal sequence | Step | Action |
| | 1 | User writes down a message in the chat box |
| | 2 | The message is presented in the chat box in the proper input order |
| Exception | Step | Action |
| | 1 | The message is not delivered into the chat box |
| Linked Use Cases | - | |
| Importance | Medium | |
| Urgency | Low | |
| Comments | - | |

Table 52: EU Scale tool: UC9. Comparison of scenarios.

| | | |
|-------------------------|---|--|
| Use case | UC9- Compare scenarios | |
| Identifier | CompareScenarios | |
| Description | The user needs to visualize two scenarios in order to compare the simulation results. | |
| Actors | All users | |
| Inputs | Two scenarios simulated or public. | |
| Outputs | Visual comparison of both scenarios sharing the same screen. | |
| Tools | EU global tool | |
| Preconditions | The user has at least two scenarios, coming from public, owned ones or shared in the sharing box. | |
| Normal sequence | Step | Action |
| | 1 | The user loads or simulates one scenario |
| | 2 | The user activates the sharing tab, and loads/draggs another scenario into the window on the right |
| Exception | Step | Action |
| | 1 | The sharing tab does not open |
| Linked Use Cases | UC2 - Navigate Created Scenario | |
| Importance | High | |
| Urgency | High | |
| Comments | - | |

13.5. Annex V: Gamification Tool Use Cases

Annex V describes in detail the use cases developed to cover the Gamification tool functionalities.

Table 53. Gamification tool: UC0, Selection Tool Mode.

| | | |
|----------------------|---|--|
| Use case | UC0 - Selection Tool Mode | |
| Identifier | ModeSelection | |
| Description | The user is able to select the mode for using the Gamification tool between individual player and group dynamic | |
| Actors | All logged users | |
| Inputs | User selection | |
| Outputs | Play mode selected | |
| Tools | The Gamification tool need to be functional | |
| Preconditions | The system has recognized the users as a logged user | |

| | | |
|-------------------------|-------------|--|
| | | The user has accessed the Gamification tool |
| | | The toolkit databases need to be functional |
| Normal sequence | Step | Action |
| | 1 | The user is the main page of the Gamification tool |
| | 2 | The user clicks on the playing mode |
| | 3 | The user is redirected to a new view for starting the game |
| Post condition | | A new window will be displayed to start using the tool |
| Exception | Step | Action |
| | 1 | The system is not running. A message is received informing users about the problem |
| | 2 | The user returns to the ICT toolkit |
| Linked Use Cases | | UC1 - Role Selection |
| Importance | | High |
| Urgency | | Medium |
| Comments | | - |

Table 54. Gamification tool: UC1, Role selection.

| | | |
|-------------------------|-------------|---|
| Use case | | UC1 - Role Selection |
| Identifier | | Role |
| Description | | The user is able to select role that will be necessary to provide useful policy recommendation before policy implementation in the Game |
| Actors | | All logged users |
| Inputs | | User selection |
| Outputs | | Role selected |
| Tools | | The Gamification tool needs to be functional |
| Preconditions | | The system has recognized the users as a logged user |
| | | The user has accessed the Gamification tool and has selected to play as individual user |
| | | The toolkit databases need to be functional |
| Normal sequence | Step | Action |
| | 1 | After selection the mode, the user is in MISSION 1 to select the playing mode |
| | 2 | The user clicks on the role to be selected |
| | 3 | The user clicks on Next to be redirected to the next interface |
| Post condition | | A new window will be displayed to start the policy parametrization |
| Exception | Step | Action |
| | 1 | The system is not running. A message is received informing users about the problem |
| | 2 | The user returns to mode selection |
| Linked Use Cases | | UC2 - Mitigation Assessment |
| Importance | | Medium |
| Urgency | | Medium |
| Comments | | - |

Table 55. Gamification tool: UC2, Mitigation Assessment.

| Use case | | UC2 - Mitigation Assessment |
|-------------------------|-------------|--|
| Identifier | | M_Assessment |
| Description | | The user is able to select the necessary policies to mitigate climate change |
| Actors | | All logged users |
| Inputs | | User policy selection |
| Outputs | | Set of parametrized policied |
| Tools | | The Gamification tool needs to be functional |
| Preconditions | | The system has recognized the users as a logged user |
| | | The user has accessed the Gamification tool, has selected to play as individual user and has selected the playing role |
| | | The toolkit databases need to be functional |
| Normal sequence | Step | Action |
| | 1 | After role selection, the user is able to parametrize policies |
| | 2 | The user read each question and click on the most feasible answer according to his knowledge and the recommendations |
| | 3 | Once all the questions are answered, the user click on Next to be redirected to the next interface |
| Post condition | | A new window will be displayed with the mitigation results |
| Exception | Step | Action |
| | 1 | The system is not running. A message is received informing users about the problem |
| | 2 | The user clicks on returns losing the included data as part of its assessment |
| Linked Use Cases | | UC3 - Mitigation Results |
| Importance | | Medium |
| Urgency | | Medium |
| Comments | | - |

Table 56. Gamification tool: UC3, Mitigation Results.

| Use case | | UC3 - Mitigation Results |
|------------------------|-------------|---|
| Identifier | | M_Results |
| Description | | The user is able to evaluate the mitigation results after answering the question (policy implementation) |
| Actors | | All logged users |
| Inputs | | Questions answered |
| Outputs | | Set of indicators and their evolution in the future |
| Tools | | The Gamification tool needs to be functional |
| Preconditions | | The system has recognized the users as a logged user |
| | | The user has accessed the Gamification tool, has selected to play as individual user and has selected the playing role |
| | | The toolkit databases need to be functional |
| Normal sequence | Step | Action |
| | 1 | After policy parametrization by means of answering a set of key questions on climate change, the user is able to evaluate the results on mitigation |

| | | |
|-------------------------|---|---|
| | 2 | The user clicks on the dropdown to select the indicators |
| | 3 | The tool grag the indicator and its evolution |
| | 4 | The temperature increase is plotted to have a clear reference on the effects |
| | 5 | Once the results are evaluated, the user clicks on Next to be redirected to Mission 2 |
| Post condition | A new window will be displayed to continue with Mission 2 | |
| Exception | Step | Action |
| | 1 | The system is not running. A message is received informing users about the problem |
| | 2 | The dropdown is representing results. A message is informing about the problem |
| | 3 | The user clicks on returns losing all the previous data |
| Linked Use Cases | UC4 - Adaptation Assessment | |
| Importance | Medium | |
| Urgency | Medium | |
| Comments | - | |

Table 57. Gamification tool: UC4, Adaptation Assessment.

| | | |
|-------------------------|--|--|
| Use case | UC4 - Adaptation Assessment | |
| Identifier | A_Assessment | |
| Description | The user is able to select the case study among the NEVERMORE case studies and the hazard object to adaptation | |
| Actors | All logged users | |
| Inputs | User selections | |
| Outputs | Case study and hazard selected | |
| Tools | The Gamification tool needs to be functional | |
| Preconditions | The system has recognized the users as a logged user | |
| | The user has accessed the Gamification tool, has selected to play as individual user and has selected the playing role | |
| | The toolkit databases need to be functional | |
| Normal sequence | Step | Action |
| | 1 | After Mission 1, the user moves to Mission 2 |
| | 2 | The user clicks on the case study for its selection |
| | 3 | The user clicks on the hazard for its selection |
| | 4 | The user clicks on Next to be redirected to the next interface |
| Post condition | A new window will be displayed to select and evaluate adaptation policies | |
| Exception | Step | Action |
| | 1 | The system is not running. A message is received informing users about the problem |
| | 2 | The user clicks on returns losing the selection |
| Linked Use Cases | UC5 - Policy Selection | |
| Importance | Medium | |
| Urgency | Medium | |
| Comments | - | |

Table 58. Gamification tool: UC5, Policy selection.

| Use case | | UC5 - Policy Selection |
|-------------------------|---|--|
| Identifier | | P_Selection |
| Description | | The user is able to select the set of policies necessary to adapt to climate change |
| Actors | | All logged users |
| Inputs | | User selections |
| Outputs | | Case study and hazard selected |
| Tools | | The Gamification tool needs to be functional |
| Preconditions | | The system has recognized the users as a logged user |
| | | The user has accessed the Gamification tool, has selected to play as individual user and has selected the playing role |
| | | The toolkit databases need to be functional |
| Normal sequence | Step | Action |
| | 1 | After case study and hazard selection, the user is starting policy selection |
| | 2 | The user clicks on each policy to be included considering the available budget |
| | 3 | The system displays the policy in a visual interface |
| | 4 | The user checks the budget in order to implement other policies |
| 5 | The user clicks on Next to be redirected to the next interface | |
| Post condition | | A new window will be displayed to evaluate the results of adaptation policies |
| Exception | Step | Action |
| | 1 | The system is not running. A message is received informing users about the problem |
| | 2 | The user clicks on returns losing the selected policies |
| 3 | The budget is not enough to include more policies. The system inform user about that. | |
| Linked Use Cases | | UC6 - Adaptation Indicators |
| Importance | | Medium |
| Urgency | | Medium |
| Comments | | - |

Table 59. Gamification tool: UC6, Adaptation Indicators.

| Use case | | UC6 - Adaptation Indicators |
|------------------------|-------------|--|
| Identifier | | KPIsAdaptation |
| Description | | The user is able evaluate the results of adaptation policies and the costs |
| Actors | | All logged users |
| Inputs | | User selected policies |
| Outputs | | Total costs, benefits and cost of inaction |
| Tools | | The Gamification tool needs to be functional |
| Preconditions | | The system has recognized the users as a logged user |
| | | The user has accessed the Gamification tool, has selected to play as individual user and has selected the playing role |
| | | The toolkit databases need to be functional |
| Normal sequence | Step | Action |
| | 1 | After adaptation policy selection, the user can check the results |

| | | |
|-------------------------|-------------|---|
| | 2 | The user is able to navigate in view cost of the selected policies by means of graphs |
| | 3 | The user click on exits to finish playing |
| Post condition | | The game ends |
| Exception | Step | Action |
| | 1 | The system is not running. A message is received informing users about the problem |
| | 2 | The user clicks on returns losing the results |
| Linked Use Cases | | - |
| Importance | | Medium |
| Urgency | | Medium |
| Comments | | - |

Table 60. Gamification tool: UC7, Group/Role Selection.

| | | |
|-------------------------|--|---|
| Use case | UC7 - Group/Role Selection | |
| Identifier | GR_selection | |
| Description | The user is able to select the goup and the role that will be necessary to provide useful policy recommendation before policy implementation in the Game | |
| Actors | All logged users | |
| Inputs | User selection | |
| Outputs | Role selected | |
| Tools | The Gamification tool needs to be functional | |
| Preconditions | The system has recognized the users as a logged user | |
| | The user has accessed the Gamification tool and has selected to play as a group user | |
| | The toolkit databases need to be functional | |
| Normal sequence | Step | Action |
| | 1 | After selection the mode, the user is in MISSION 1 to select the playing mode |
| | 2 | The user clicks on the dropdown to select the time. A default message is presented to share the group with the user |
| | 3 | The user clicks on the group to be selected |
| | 4 | The user clicks on the role to be selected |
| | 5 | The user clicks on Next to be redirected to the next interface |
| Post condition | | A new window will be displayed to start the policy parametrization |
| Exception | Step | Action |
| | 1 | The system is not running. A message is received informing users about the problem |
| | 2 | The user returns to mode selection |
| Linked Use Cases | | UC8 - Team Mitigation Assessment |
| Importance | | Medium |
| Urgency | | Medium |
| Comments | | - |

Table 61. Gamification tool: UC8, Team Mitigation Assessment.

| Use case | | UC8 - Team Mitigation Assessment |
|-------------------------|-------------|---|
| Identifier | | TM_Assessment |
| Description | | The user is able to select the necessary policies to mitigate climate change |
| Actors | | All logged users |
| Inputs | | User policy selection |
| Outputs | | Set of parametrized policied |
| Tools | | The Gamification tool needs to be functional |
| Preconditions | | The system has recognized the users as a logged user |
| | | The user has accessed the Gamification tool, has selected to play as group user and has selected the team and playing role |
| | | The toolkit databases need to be functional |
| Normal sequence | Step | Action |
| | 1 | After team and role selection, the user is able to parametrize policies. To this end, a consensus between all the team players is necessary. A chat is provided to discuss on the most feasible answers |
| | 2 | The user read each question and click on the most feasible answer according to his knowledge and the recommendations |
| | 3 | Once all the questions are answered, the user click on Next to be redirected to the next interface |
| Post condition | | A new window will be displayed with the mitigation results |
| Exception | Step | Action |
| | 1 | The system is not running. A message is received informing users about the problem |
| | 2 | The user clicks on returns losing the included data |
| Linked Use Cases | | UC9 - Team Mitigation Results |
| Importance | | Medium |
| Urgency | | Medium |
| Comments | | - |

Table 62. Gamification tool: UC9, Team Mitigation Results.

| Use case | | UC9 - Team Mitigation Results |
|------------------------|-------------|--|
| Identifier | | TM_Results |
| Description | | The user is able to evaluate the mitigation results after answering the question (policy implementation) |
| Actors | | All logged users |
| Inputs | | Questions answered |
| Outputs | | Set of indicators and their evolution in the future |
| Tools | | The Gamification tool needs to be functional |
| Preconditions | | The system has recognized the users as a logged user |
| | | The user has accessed the Gamification tool, has selected to play as group user and has selected the team and playing role |
| | | The toolkit databases need to be functional |
| Normal sequence | Step | Action |

| | | |
|-------------------------|-------------|--|
| | 1 | After policy parametrization by means of answering a set of key questions on climate change, the team users are able to evaluate the results on mitigation |
| | 2 | The user clicks on the dropdown to select the indicators |
| | 3 | The tool graphs the indicator and its evolution |
| | 4 | The temperature increase is plotted to have a clear reference on the effects |
| | 5 | Once the results are evaluated, the user click on Next to be redirected to Mission 2 |
| Post condition | | A new window will be displayed to continue with Mission 2 |
| Exception | Step | Action |
| | 1 | The system is not running. A message is received informing users about the problem |
| | 2 | The dropdown is representing results. A message is informing about the problem |
| | 3 | The user clicks on returns losing all the previous data |
| Linked Use Cases | | UC10 - Results Comparison Mitigation |
| Importance | | Medium |
| Urgency | | Medium |
| Comments | | - |

Table 63. Gamification tool: UC10, Results Comparison Mitigation.

| | | |
|-------------------------|-------------|--|
| Use case | | UC10 - Results Comparison Mitigation |
| Identifier | | Results_ComparisonM |
| Description | | The user is able to compare the mitigation results of the different choices by the teams on policy questions |
| Actors | | All logged users |
| Inputs | | Questions answered |
| Outputs | | Temperature as the main indicator |
| Tools | | The Gamification tool needs to be functional |
| Preconditions | | The system has recognized the users as a logged user |
| | | The user has accessed the Gamification tool, has selected to play as group user and has selected the team and playing role |
| | | The toolkit databases need to be functional |
| Normal sequence | Step | Action |
| | 1 | After policy mitigation results, the tool presents the temperature increase obtained by group as a results of policy choices |
| | 2 | Once the results are compared, the user click on Next to be redirected to Mission 2 |
| Post condition | | A new window will be displayed to continue with Mission 2 |
| Exception | Step | Action |
| | 1 | The system is not running. A message is received informing users about the problem |
| | 2 | The dropdown is representing results. A message is informing about the problem |
| | 3 | The user clicks on returns losing all the previous data |
| Linked Use Cases | | UC11 - Team Adaptation Assessment |
| Importance | | Medium |
| Urgency | | Medium |
| Comments | | - |

Table 64. Gamification tool: UC11, Team Adaptations Assessment.

| Use case | | UC11 - Team Adaptation Assessment |
|-------------------------|-------------|--|
| Identifier | | TA_Assessment |
| Description | | The user as part of a group, is able to select the case study among the NEVERMORE case studies and the hazard object to adaptation |
| Actors | | All logged users |
| Inputs | | User selections |
| Outputs | | Case study and hazard selected |
| Tools | | The Gamification tool needs to be functional |
| Preconditions | | The system has recognized the users as a logged user |
| | | The user has accessed the Gamification tool, has selected to play as group user and has selected the team and playing role |
| | | The toolkit databases need to be functional |
| Normal sequence | Step | Action |
| | 1 | After Mission 1, the user moves to Mission 2 |
| | 2 | The user clicks on the case study for its selection considering the recommendations |
| | 3 | The user clicks on the hazard for its selection considering the recommendations |
| | 4 | The user clicks on Next to be redirected to the next interface |
| Post condition | | A new window will be displayed to select and evaluate adaptation policies |
| Exception | Step | Action |
| | 1 | The system is not running. A message is received informing users about the problem |
| | 2 | The user clicks on returns losing the selection |
| Linked Use Cases | | UC12 - Team Policy Selection |
| Importance | | Medium |
| Urgency | | Medium |
| Comments | | - |

Table 65. Gamification tool: UC12, Team Policy Selection.

| Use case | | UC12 - Team Policy Selection |
|------------------------|-------------|--|
| Identifier | | TP_Selection |
| Description | | The user is able to select the set of policies necessary to adapt to climate change |
| Actors | | All logged users |
| Inputs | | User selections |
| Outputs | | Case study and hazard selected |
| Tools | | The Gamification tool needs to be functional |
| Preconditions | | The system has recognized the users as a logged user |
| | | The user has accessed the Gamification tool, has selected to play as group user and has selected the team and playing role |
| | | The toolkit databases need to be functional |
| Normal sequence | Step | Action |
| | 1 | After case study and hazard selection, the user is staring policy selection |

| | | |
|-------------------------|-------------|---|
| | 2 | The user clicks on each policy to be included considering the available budget. A consensus between all team member is necessary. A chat is provided to improve the user interactions |
| | 3 | The system displays the policy in a visual interface |
| | 4 | The user checks the budget in order to implement other policies |
| | 5 | The user clicks on Next to be redirected to the next interface |
| Post condition | | A new window will be displayed to evaluate the results of adaptation policies |
| Exception | Step | Action |
| | 1 | The system is not running. A message is received informing users about the problem |
| | 2 | The user clicks on returns losing the selected policies |
| | 3 | The budged is not enough to include more policies. The system inform user about that. |
| Linked Use Cases | | UC13 - Results Comparison Adaptation |
| Importance | | Medium |
| Urgency | | Medium |
| Comments | | - |

Table 66. Gamification tool: UC13, Results Comparison Adaptation.

| | | |
|-------------------------|-------------|--|
| Use case | | UC13 - Results Comparison Adaptation |
| Identifier | | Results_ComparisonM |
| Description | | The user is able to compare the mitigation results of the different choices by the teams on policy questions |
| Actors | | All logged users |
| Inputs | | Questions answered |
| Outputs | | Temperature as the main indicator |
| Tools | | The Gamification tool needs to be functional |
| Preconditions | | The system has recognized the users as a logged user |
| | | The user has accessed the Gamification tool, has selected to play as group user and has selected the team and playing role |
| | | The toolkit databases need to be functional |
| Normal sequence | Step | Action |
| | 1 | After adaptation policy selection, the user can check and compare the results between groups |
| | 2 | The user is able to navigate in view cost of the selected policies in each team |
| | 3 | The system includes the medals according to the cost and benefits |
| | 4 | The user click on exits to finish playing |
| Post condition | | A new window will be displayed to continue with Mission 2 |
| Exception | Step | Action |
| | 1 | The system is not running. A message is received informing users about the problem |
| | 2 | The user clicks on returns losing the results |
| Linked Use Cases | | - |
| Importance | | Medium |



New Enabling Visions and Tools for End-useRs and stakeholders thanks to a common MOdeling appRoach towards a ClimatE neutral and resilient society

| | |
|-----------------|--------|
| Urgency | Medium |
| Comments | - |



NEVER MORE

Contacts

Fondazione Bruno Kessler

E-mail: nevermore-communication@fbk.eu

Phone: +39 0461 314444

Fax. +39 0461 314444

via Sommarive, 18,

cp: 38123 Povo TN, Italia



This project has received funding from the European Union’s Horizon Europe research and innovation programme under grant agreement No 101056858.