**GENIE Project Mid-Term Scientific Report**

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**Deliverable Version:**

**Dissemination Level:**

**Authors:**

**Contributors:**

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Table of Contents

[**Deliverable** 2](#_Toc134015513)

[**Disclaimer** 3](#_Toc134015514)

[Introduction 4](#_Toc134015515)

[General Ethical Principles for Protection of Personal Data 4](#_Toc134015516)

[Mid-term Scientific Report 5](#_Toc134015517)

[Publications 0](#_Toc134015518)

[1. Publications from GENIE Project by partner 0](#_Toc134015519)

[1.1. Publications from Aarhus University 0](#_Toc134015520)

[1.2. Publications from International Institute on Applied Systems Analysis (IIASA) 3](#_Toc134015521)

[1.3 Publications from Mercator Research Institute on Global Commons and Climate Change (MCC) 3](#_Toc134015522)

[1.4 Publications from University of Wisconsin-Madison 4](#_Toc134015523)

[2. Summary of the major achievements since the start of action 5](#_Toc134015524)

[2.1 Summary from Aarhus University 5](#_Toc134015525)

[2.2 Summary from IIASA 6](#_Toc134015526)

[2.3 Summary from MCC 8](#_Toc134015527)

[2.4 Summary from UWISC 9](#_Toc134015528)

[3. Major Challenges 11](#_Toc134015529)

[3.1 Major Challenges from Aarhus University 11](#_Toc134015530)

[3.2 Major Challenges from IIASA 12](#_Toc134015531)

[3.3 Major Challenges from MCC 13](#_Toc134015532)

[3.4 Major Challenges from UWISC 14](#_Toc134015533)

[4 Expeditions and Awards 15](#_Toc134015534)

[4.1 Aarhus University 15](#_Toc134015535)

[4.2 IIASA 16](#_Toc134015536)

[4.3 MCC 16](#_Toc134015537)

[4.4 UWISC 17](#_Toc134015538)

[4. Disseminations and Outputs 18](#_Toc134015539)

[4.1 Aarhus University 18](#_Toc134015540)

[4.2 IIASA 18](#_Toc134015541)

[4.3 MCC 18](#_Toc134015542)

[4.4 USIC 19](#_Toc134015543)

[5. List of free keywords 19](#_Toc134015544)

[Compliance with European Union Ethical Principles 19](#_Toc134015545)

# **Deliverable**

**Mid-Term Scientific Report**

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| --- | --- |
| **Project:** | GeoEngineering and Negative Emissions Pathways in Europe |
| **Acronym:** | GENIE |
| **Grant Agreement:** | 951542 |
| **Funding Scheme:** | Horizon 2020 |
| **Webpage:** | https://genie-erc.github.io/ |
| **Work Package:** |  |
| **Work Package Leader:** |  |
| **Deliverable Title:** | Mid-term scientific report |
| **Deliverable Number:** |  |
| **Deliverable Leader:** |  |
| **Involved Beneficiaries:** |  |
| **Dissemination Level:** |  |
| **Version:** | 1.0 |
| **Status:** |  |
| **Authors:** |  |
| **Reviewed By:** |  |
| **Approved By:** |  |
| **Date:** | 7 May 2025 |

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| --- | --- | --- | --- |
| **Revision History** | **Reviewed By** | **Date** | **Summary of Changes** |
| Version 1.0 |  | 7 May 2025 | Initial template for scientific report |

# **Disclaimer**

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# Introduction

The path to climate neutrality needs to explicitly consider the roles of solar geoengineering and negative emissions technologies. A meta-analytical framework where social science, engineering, and physical science disciplines merge is necessary for a comprehensive mapping of this transition. The EU-funded GENIE project will explore the environmental, technical, social, legal, ethical, and policy dimensions of greenhouse gas removal and solar radiation management. GENIE aims to produce a comprehensive scientific assessment for evidence-based policymaking to address climate change and to expand our toolkit for a zero-emissions future.

Geoengineering technologies, such as solar radiation management (SRM), and negative emissions technologies, such as greenhouse gas removal (GGR), are emerging options to address climate change. This project will investigate the environmental, technical, social, legal, and policy dimensions of GGR and SRM. We provide an urgently needed interdisciplinary and holistic perspective of these technologies in order to understand conditions under which they might be deployed at scale. Our meta-analytical framework integrates insights from social science, engineering, and physical science disciplines to provide a comprehensive view of GGR and SRM in the transition to climate neutrality in Europe and the world. The project will conduct excellent research and generate a robust, scientific assessment for evidence-based policymaking. Our research framework consists of three pillars—techno-economic systems, socio-technical systems, and systems of political action—within which we place six work packages (WPs). These are: (1) Understanding the current state and future potential of GGR and SRM technologies in terms of their technical and economic features; (2) Analysing bottlenecks in transitions to climate neutrality and their implications for deployment; (3) Identifying social acceptance and legitimacy constraints, (4) Learning, diffusion, and adoption; (5) Implications for Sustainable Development Goals of archetypical mitigation pathways; and 6) Policy options and governance. A crosscutting WP7 synthesizes research along three salient, but under-researched themes: A) Socio-technical change; B) Managing transition risks; and C) Political economy and feasibility of deployment. WP8 focuses on stakeholder engagement, entailing scenario co-design, science-policy dialogue formats, and specific outreach formats for target groups.

# General Ethical Principles for Protection of Personal Data

For protection of personal data entered during the GENIE Project, the following general ethical guidelines are considered:

* No vulnerable or high-risk groups (e.g., children, adults unable to consent, people in dependency relationships, vulnerable persons) will be addressed during the development and progress of the GENIE project;
* No human research subjects will be used and studied during the GENIE project;
* Persons are approached in their professional capacity;
* GENIE Project participants reserve the right to terminate their communication with the GENIE Project and unsubscribe from any communication at anytime upon request;
* Minimum and limited amount of personal data will be collected;
* Personal contact data will be kept internally within the GENIE Project and will not be accessible to external organizations or individuals.

# Mid-term Scientific Report

The mid-term scientific report contains a summary of the scientific progress that allows Scientific Officers to monitor the implementation of the work and reported achievements again the commitments in the GENIE Project’s “Description of Action.”

**This report contains a summary of the GENIE Project form 1 May 2023- 30 April 2025.**

Summary of the context and overall objectives of the project (For the final period, include the conclusions of the action)

This section should include information on:

What is the problem/issue being addressed?

Why is it important for society?

What are the overall objectives?

Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far (For the final period please include an overview of the results and their exploitation and dissemination)

Progress beyond the state of the art and expected results until the end of the project

# Publications

## Publications from GENIE Project by partner

**NOTE: In the interest in keeping the document clean, please submit your publications here:** [**https://bit.ly/44qHx4W**](https://bit.ly/44qHx4W)

Report all publications resulting from your ERC project by encoding (1) the doi of the publication (this should point to the version of record, i.e., the original publication) and (2) the doi of the deposited version (i.e., the repository).

For each publication, ensure that:

* ERC funding is acknowledged;
* the final version of the manuscript or published version is deposited in an institutional, discipline-specific, or general-purpose open access repository;
* the “repository link” points to the deposited version in an Open Science repository. This link should not lead to the publisher’s website, your own website, nor to platforms such as ResearchGate or Academia.edu.

NOTE: If you have manuscripts under review at the time of mid-term scientific report, mention these in the “Major Achievements” section. However, abstracts, posters, slides, conference programs, etc. should not be included in this publication list. Report participation in major conferences in the Dissemination and Outputs section.

**The division of publications by partner is only for this document. Publications are not divided by institution on the submitted report.**

**Publications with the titles below are already entered into the system not required to be submitted.**

## Publications from Aarhus University

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| **Type** | **Title** | **Authors** | **Title of Journal/Proc./Book** | **Number, date or freq. of the Journal/Proc./Book** | **Is Peer-reviewed?** | **Is Open Access?** | **DOI** | **Repository Link** |
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Below is a summary of publications from Aarhus University for the mid-term scientific report.

## Publications from International Institute on Applied Systems Analysis (IIASA)

Below is a summary of publications from Aarhus University for the mid-term scientific report.

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| **Type** | **Title** | **Authors** | **Title of Journal/Proc./Book** | **Number, date or freq. of the Journal/Proc./Book** | **Is Peer-reviewed?** | **Is Open Access?** | **DOI** | **Repository Link** |
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## Publications from Potsdam Institute for Climate Impact Research (PIK)

Below is a summary of publications from Aarhus University for the mid-term scientific report.

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| **Type** | **Title** | **Authors** | **Title of Journal/Proc./Book** | **Number, date or freq. of the Journal/Proc./Book** | **Is Peer-reviewed?** | **Is Open Access?** | **DOI** | **Repository Link** |
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## Publications from University of Wisconsin-Madison

Below is a summary of publications from Aarhus University for the mid-term scientific report.

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| **Type** | **Title** | **Authors** | **Title of Journal/Proc./Book** | **Number, date or freq. of the Journal/Proc./Book** | **Is Peer-reviewed?** | **Is Open Access?** | **DOI** | **Repository Link** |
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# Summary of the major achievements since the start of action

Explain in a clear manner the work performed during the period covered by this report along with the main objectives/activities foreseen in the Description of the Action.

**Please keep each section contribution less than 1,500 characters. Total contribution character limit for each section is 6,000 characters.**

Please connect each achievement, where appropriate, with the relevant publication/conference presentation indicated in the other sections.

## 2.1 Summary from Aarhus University

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### 2.1.1 Research and technological achievements along the main objectives/activities (in line with the Description of the Action)

### 2.1.2 If applicable: novel methodologies, and/or inter-disciplinary developments, and/or knowledge and technology transfer.

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### 2.1.3 Indicate what you would consider to be the (up to) five most significant achievements in your project (e.g. the five most important scientific publications and other research outputs, patents, interactions with stakeholders such as industry or policy makers, media reports or events, etc.)

|  |
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### 2.1.4 Would you consider any of these significant achievements as breakthroughs or as advancing a research field significantly beyond the state of the art? Were any of these unplanned/ unexpected? Give a brief explanation

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### 2.1.5 Describe the evolution and composition of each Principal Investigator’s research team involved in the Synergy project

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### 2.1.6 Describe the Synergy aspects of the project, such as joint working arrangements, mobility of postdocs and students, common activities and exchange of methodologies for all teams involved in the Synergy project. If applicable, comment on emerging/transformative research and cross-fertilisation of scientific fields and connect them with key joint publications or any other output arising from the Synergy aspects.

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## 2.2 Summary from IIASA

### 2.2.1 Research and technological achievements along the main objectives/activities (in line with the Description of the Action)

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### 2.2.2 If applicable: novel methodologies, and/or inter-disciplinary developments, and/or knowledge and technology transfer.

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### 2.2.3 Indicate what you would consider to be the (up to) five most significant achievements in your project (e.g. the five most important scientific publications and other research outputs, patents, interactions with stakeholders such as industry or policy makers, media reports or events, etc.).

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### 2.2.4 Would you consider any of these significant achievements as breakthroughs or as advancing a research field significantly beyond the state of the art? Were any of these unplanned/ unexpected? Give a brief explanation

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### 2.2.5 Describe the evolution and composition of each Principal Investigator’s research team involved in the Synergy project

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### 2.2.6 Describe the Synergy aspects of the project, such as joint working arrangements, mobility of postdocs and students, common activities and exchange of methodologies for all teams involved in the Synergy project. If applicable, comment on emerging/transformative research and cross-fertilisation of scientific fields and connect them with key joint publications or any other output arising from the Synergy aspects.

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## 2.3 Summary from PIK

### 2.3.1 Research and technological achievements along the main objectives/activities (in line with the Description of the Action)

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### 2.3.2 If applicable: novel methodologies, and/or inter-disciplinary developments, and/or knowledge and technology transfer.

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### 2.3.3 Indicate what you would consider to be the (up to) five most significant achievements in your project (e.g. the five most important scientific publications and other research outputs, patents, interactions with stakeholders such as industry or policy makers, media reports or events, etc.).

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### 2.3.4 Would you consider any of these significant achievements as breakthroughs or as advancing a research field significantly beyond the state of the art? Were any of these unplanned/ unexpected? Give a brief explanation

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### 2.3.5 Describe the evolution and composition of each Principal Investigator’s research team involved in the Synergy project

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### 2.3.6 Describe the Synergy aspects of the project, such as joint working arrangements, mobility of postdocs and students, common activities and exchange of methodologies for all teams involved in the Synergy project. If applicable, comment on emerging/transformative research and cross-fertilisation of scientific fields and connect them with key joint publications or any other output arising from the Synergy aspects.

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## 2.4 Summary from UWISC

### 2.4.1 Research and technological achievements along the main objectives/activities (in line with the Description of the Action)

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### 2.4.2 If applicable: novel methodologies, and/or inter-disciplinary developments, and/or knowledge and technology transfer.

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### 2.4.3 Indicate what you would consider to be the (up to) five most significant achievements in your project (e.g. the five most important scientific publications and other research outputs, patents, interactions with stakeholders such as industry or policy makers, media reports or events, etc.).

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### 2.4.4 Would you consider any of these significant achievements as breakthroughs or as advancing a research field significantly beyond the state of the art? Were any of these unplanned/ unexpected? Give a brief explanation.

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### 2.4.5 Describe the evolution and composition of each Principal Investigator’s research team involved in the Synergy project

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### 2.4.6 Describe the Synergy aspects of the project, such as joint working arrangements, mobility of postdocs and students, common activities and exchange of methodologies for all teams involved in the Synergy project. If applicable, comment on emerging/transformative research and cross-fertilisation of scientific fields and connect them with key joint publications or any other output arising from the Synergy aspects.

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## 

# Major Challenges

Specify any major challenges, if any, you have encountered to date or anticipate in the near future related to the implementation of your research project, including any specific challenges linked to the implementation of the Synergy collaboration. Where appropriate, indicate any changes of direction you envisage.

**Please keep each contribution in each section less than 1,000 characters. The total characters in each section for final report is 4,000 characters.**

## 3.1 Major Challenges from Aarhus University

### 3.1.1 Scientific challenges

|  |
| --- |
|  |

### 3.1.2 Technical challenges

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### 3.1.3 Issues related to the support provided by the Host Institution (Start-up facilities, working space, access to labs, equipment, resources, etc.)

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### 3.1.4 Other

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## 3.2 Major Challenges from IIASA

### 3.2.1 Scientific challenges

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| --- |
|  |

### 3.2.2 Technical challenges

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### 3.2.3 Issues related to the support provided by the Host Institution (Start-up facilities, working space, access to labs, equipment, resources, etc.)

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### 3.2.4 Other

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## 3.3 Major Challenges from PIK

### 3.3.1 Scientific challenges

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### 3.3.2 Technical challenges

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### 3.3.3 Issues related to the support provided by the Host Institution (Start-up facilities, working space, access to labs, equipment, resources, etc.)

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### 3.3.4 Other

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## 3.4 Major Challenges from UWISC

### 3.4.1 Scientific challenges

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### 3.4.2 Technical challenges

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### 3.4.3 Issues related to the support provided by the Host Institution (Start-up facilities, working space, access to labs, equipment, resources, etc.)

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### 3.4.4 Other

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# 

# Expeditions and Awards

## 4.1 Aarhus University

### 2.1.1 Research Expeditions

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| --- | --- | --- | --- |
| Period | Place | Purpose | Action |
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### 4.1.2 Awards and Recognitions

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| --- | --- | --- | --- | --- | --- | --- |
| Award Type | Title of Award | Recipient of Award | Year | Short description of the reason the award was made | Any additional information or clarification | Actions |
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## 4.2 IIASA

### 4.2.1 Research Expeditions

|  |  |  |  |
| --- | --- | --- | --- |
| Period | Place | Purpose | Action |
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### 4.2.2 Awards and Recognitions

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| Award Type | Title of Award | Recipient of Award | Year | Short description of the reason the award was made | Any additional information or clarification | Actions |
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## 4.3 MCC

### 4.3.1 Research Expeditions

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| Period | Place | Purpose | Action |
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### 4.3.2 Awards and Recognitions

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| Award Type | Title of Award | Recipient of Award | Year | Short description of the reason the award was made | Any additional information or clarification | Actions |
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## 4.4 UWISC

### 4.4.1 Research Expeditions

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| Period | Place | Purpose | Action |
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### 4.4.2 Awards and Recognitions

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# Disseminations and Outputs

## 4.1 Aarhus University

### 4.1.1 Dissemination of results to academic and non-academic audience that you would like to highlight

|  |  |  |  |  |  |  |  |  |
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| Type of Activity | Main Leader | Title | Date | Place | Type of Audience | Size of Audience | Countries Addressed | Actions |
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### 4.1.2 Information on other important outputs that have arisen from this project.

This includes software, databases, exhibitions, or other types of output

## 4.2 IIASA

### 4.2.1 Dissemination of results to academic and non-academic audience that you would like to highlight

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Type of Activity | Main Leader | Title | Date | Place | Type of Audience | Size of Audience | Countries Addressed | Actions |
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### 4.2.2 Information on other important outputs that have arisen from this project.

This includes software, databases, exhibitions, or other types of output

## 4.3 MCC

### 4.3.1 Dissemination of results to academic and non-academic audience that you would like to highlight

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| Type of Activity | Main Leader | Title | Date | Place | Type of Audience | Size of Audience | Countries Addressed | Actions |
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### 4.3.2 Information on other important outputs that have arisen from this project.

This includes software, databases, exhibitions, or other types of output

## 4.4 USIC

### 4.4.1 Dissemination of results to academic and non-academic audience that you would like to highlight

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| Type of Activity | Main Leader | Title | Date | Place | Type of Audience | Size of Audience | Countries Addressed | Actions |
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### 4.4.2 Information on other important outputs that have arisen from this project.

This includes software, databases, exhibitions, or other types of output

# List of free keywords

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# Compliance with European Union Ethical Principles

GENIE Project will comply with Hoizon 2020 ethical standards and guidelines and the EU Directive on data protection and with any updates it may receive during the life of the project. The GENIE Project also commits to abide by the provisions of GDPR and its revisions for the collection and processing of personal data in meetings, surveys, interviews, and dissemination activities.