DELIVERABLE D7.5 THERMOFIRE

– Data Management Plan M6-Version 1.1

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List of acronyms

Abbreviation / Acronym	Description
DMP	Data Management Plan
ORDP	Open Research Data Pilot
GDPR	General Data Protection Regulation
IPR	Intellectual Property Right
DSS	Decision Support System
DoA	Description of Action
SOPs	Standard Operating Procedures
FAIR	Findability (F), Accessibility (A), Interoperability (I), and Reusability (R)
TRL	Technological Readiness Level
TOs	Technological Objectives
EOS	Economic objectives
ENOS	Environmental objectives
SWOT	Strengths, Weaknesses, Opportunities and Threats
RDA	Research Data Alliance

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Executive summary

This Data Management Plan (DMP) serves as a comprehensive guide to the strategic handling and utilization of organizational data. Designed to ensure the integrity, security, and accessibility of our data assets, the plan outlines key components such as a robust data governance framework, lifecycle management strategies, security measures, metadata standardization, backup and disaster recovery protocols, and data quality assurance processes. By implementing these measures, we aim to enhance decision-making, ensure regulatory compliance, and improve operational efficiency. This document provides a roadmap for effectively managing our data resources and supporting our broader business objectives. The DMP will be conducted by AVA, in collaboration with the rest of the partners of the project, in task of WP 7 of the THERMOFIRE project.

1. Introduction

The "Data Management Plan" (DMP) for project THERMOFIRE has been developed to guide and oversee the creation and management of both new and existing data, as well as protocols, standard operating procedures (SOPs), and tools essential for the project. It serves as an evolving internal reference document, setting the standards and prerequisites for data management, labeling, and curation within the project.

The DMP also sheds light on how newly acquired data, information, and knowledge will be leveraged in populating the central THERMOFIRE database hosted on OneDrive. Collective decisions by THERMOFIRE partners, on a case-by-case basis, determine which portions of the research data will be shared beyond the consortium, adhering to FAIR principles for maximum reusability.

Confidentiality and data access restrictions are considered when needed, safeguarding Intellectual Property Rights (IPRs) and privacy. The primary objective of this DMP is to outline data attributes and legal or ethical requirements before collecting or sharing identifiable information.

Effective data management is crucial for various reasons, including protecting costly data, ensuring the foundation of high-quality research, compliance with ethical standards, privacy laws, and funding policies, and facilitating replication and reproducibility. A well-structured data management plan ensures data protection from loss and damage.

To enhance research transparency and reporting accuracy, the THERMOFIRE DMP promotes data collection, sharing, quality checks, collaboration, and communication. It also addresses data confidentiality, storage, retention, and sharing duration.

In summary, a data management plan is a vital document for guiding data collection, management, and sharing throughout the THERMOFIRE project. It ensures that project teams have the necessary information for success and builds trust among partners by addressing data confidentiality and protection

1.1. Scope of deliverable

As outlined in the Description of Action (DoA), the Data Management Plan (DMP) will be promptly established and implemented throughout the project's duration. The DMP will play a pivotal role in guiding the coordination of data collection, generation, assessment, and utilization, including protocols such as Standard Operating Procedures (SOPs). It will adhere to the FAIR principles, which emphasize enhancing the Findability (F), Accessibility (A), Interoperability (I), and Reusability (R) of data.

Additionally, the DMP will address the secure handling and preservation of data, both during the project's lifecycle and after its conclusion, ensuring the long-term viability of the information. [1]

https://www.go-fair.org/fair-principles/i3-metadata-include-qualified-references-metadata/ .

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1.2. Purpose of the deliverable

The purpose of a Deliverable Data Management Plan (DMP) is to provide a structured framework and guidelines for how data will be managed, organized, and utilized throughout the course of a project or research endeavor. It serves several essential purposes, including:

1. Data Coordination: A DMP helps coordinate the collection, generation, evaluation, and use of data, ensuring that data-related activities are well-organized and aligned with the project's goals.
2. Data Quality and Integrity: It outlines procedures for maintaining data quality and integrity, which is crucial for ensuring the reliability of research outcomes and compliance with ethical standards.
3. Data Accessibility: The DMP describes how data will be stored and made accessible to project team members and, in some cases, external partners or the public. This enhances transparency and collaboration.
4. Compliance: It ensures that data management practices adhere to legal and ethical requirements, including data protection regulations, privacy laws, and intellectual property rights.
5. Data Preservation: The plan addresses the long-term preservation and retention of data, safeguarding it for future reference, analysis, and potential reuse.
6. Risk Mitigation: A DMP helps identify and mitigate risks associated with data management, such as data loss, security breaches, or privacy violations.
7. Communication and Collaboration: It fosters communication and collaboration among project team members regarding data-related activities, promoting a shared understanding of data handling procedures.
8. Reproducibility and Verification: By outlining data management processes, the DMP supports the reproducibility and verification of research findings, a fundamental aspect of scientific rigor.
9. Project Continuity: It ensures that data will be available and manageable even after the project's completion, allowing for the continuation of research or the transfer of knowledge.
10. FAIR Principles: The DMP may incorporate the FAIR principles, emphasizing Findability, Accessibility, Interoperability, and Reusability of data. This makes data more valuable and usable for the broader research community. Compliance with FAIR principles of the data management in the best way possible Is an important purpose of the DMP. Working with big data (volume, variety, variability, and veracity) and challenges in reproducing, sharing, and integrating them are a relevant concern even in material science domain. These principal challenges are related to problems of locating, retrieving, and integrating data, therefore FAIR principles have been introduced with the aim of supporting machines to automatically find and use data and individuals to reuse data. Within different areas, research is underway to align data management with FAIR principles ([2] https://doi.org/10.5334/dsj-2019-050). The concept of Open Data is more widespread than that of FAIR Data. The definition of FAIR Data is included in its own name (being the acronym of Findable, Accessible, Interoperable, and Reusable), however, such data are not always available on open access for everyone. On the other hand, Open Data, according to the definition of the Open Data Handbook, are “data that can be used, reused and redistributed freely by any person, and that are subject, at most, to the requirement of attribution and to be shared in the same manner in which they appear”. ([3] http://opendatahandbook.org/guide/en/what-is-open-data/). In terms, FAIR Data does not have to be open, being accessible only for the researchers of the group which are currently working on it. So all the data must be treated as open as possible, as closed as necessary)[4] https://direct.mit.edu/dint/article/2/1-2/47/9998/The-A-of-FAIR-As-Open-as-Possible-as-Closed-as) like FAIR Data motto says ([5] https://dmeg.cessda.eu/Data-Management-Expert-Guide/1.-Plan/FAIR-data). On the contrary, in some cases not all Open Data have to be FAIR. A data set ([6] https://www.indeed.com/career-advice/career-development/what-is-data-set) with a data license ([7] https://data.europa.eu/en/training/elearning/open-data-licensing) may be archived in a repository that cannot be found. Metadata itself is one of the recognized enablers of the fairness principle, and the next steps are ontologies. Ontologies provide a common, standardized representation of domain knowledge. Using an ontology to describe data makes data more findable. Accessibility can be improved by using ontologies to represent metadata. Interoperability is achieved by using the same terms defined by the ontology. Finally, reusability is supported through the sharing and standardization of ontologies.

2. Overview

This DMP for THERMOFIRE is based on the Horizon Europe Data Management Plan Template (EU Grants: Data Management Template (HE): V1.0 – 05.05.2021).

This DMP will focus on the following topics described in detail below:

(1) how research data will be collected, processed, or generated within the project,

(2) what methodology and standards will be applied,

(3) whether and how this data will be shared and/or disclosed, and

(4) how this data will be curated and retained during and after the project.

The DMP aims to ensure that THERMOFIRE activities are compliant with the H2020 Open Access Policy and the recommendations of the Open Research Data Pilot, such as the FAIR Policy. It will serve as official guidance to Project Partners on data management. The DMP is a living document and each time the data, its impact, or its accessibility changes, the document will be adapted accordingly. In this way, it can be constantly updated and developed throughout the duration of the project.

3. Description of task

In THERMOFIRE WP7, dedicated to project management and coordination is also taking the overview of the DMP, that has been developed by AVANZARE (AVA) and the help of all other key partners. All the new data will be findable, accessible, interoperable, and reusable according to the FAIR principle by a Project data management. The project adopts several practices to share its findings with the European research community and businesses, as well as citizens. Key aspects of the information management strategy include:

1. Open Access Publications: THERMOFIRE ensures open access to all peer-reviewed scientific publications through platforms like Polymers, the project's website, and the European open access repository Zenodo.org. This supports a shift towards an economically sustainable open publication model.
2. Early Access to Results: The scientific community gains early access to THERMOFIRE's results through informal publications on reputable online repositories.
3. Open Peer Review: THERMOFIRE encourages open peer review, allowing self-selected reviewers to provide comments on scientific outputs beyond those selected by journals. Project partners actively participate as open peer reviewers for related projects.
4. Open Research Europe Publishing Platform (OREPP): Articles, including a project overview and concluding summary, will be published on OREPP at the project's beginning and end, respectively.
5. Open-Source Software (OSS): Academic partners' developments are shared as open-source software on GitHub. The project commits to a business-friendly license for reproducibility and third-party benefit.
6. Open Data and FAIR Data: All project datasets are anonymized and shared as open data in various FAIR repositories such as EOSC, OpenAIRE, re3data.org, EUDAT, and DataHub.
7. Open Innovation: THERMOFIRE actively promotes open innovation through collaborations with academic and business networks, Horizon EU clusters, and stakeholders in diverse sectors. The goal is to adapt and extend developed systems and techniques while sharing ideas, knowledge, and best practices for broader adoption.

All data handling will take place under the principles of the following conventions: The EU General Data Protection Regulation 2016/679, The EU Charter of Fundamental Rights, The European Convention on Human Rights, The Universal Declaration of Human Rights, The convention for the Protection of Individuals with regard to Automatic Processing of Personal Data. THERMOFIRE will create a suitable format at OneDrive for internal data sharing and stored in relevant file formats (e.g., Excel/CSV) among

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partners, and whenever possible with all other stakeholders outside the project (regulators, industries, academia and the general public), as long as there are no conflicts with IPR protection etc.

The THERMOFIRE DMP is describing how the data, protocols, SOPs, and tools will be managed, shared, and stored, what standards will be used, and how they will be handled and protected during and after the completion of the project. But to do so, research participants must provide consent for the data, protocols, SOPs, and tools to be accessible, repurposed (fit for a future known research activity), and reused (for a research purpose or activity other than that for which it was intended). We will communicate and share all available data, information, and knowledge on material risk with different stakeholders, problem owners, and societal groups in a synthetic and easy-to-grasp manner to stimulate discussion, reflection, and the acceptance of new products. The aim is that datasets can be reused for purposes very different from the original research, and the combination of multiple existing datasets can provide an efficient starting point for other research projects. The idea for open access publication of study outcomes along with the associated data is to increase social good transparency and research verification.

4. Description of work & main achievements

In order to obtain the initial information, a preliminary data inventory on the anticipated data to be produced, collected, and (re-)used in THERMOFIRE (see Annex Tables 1, 2 and 3) has already been implemented.

We will conduct continuous data inventory update to ensure that the produced data can be made available as soon as possible to all project partners, but also to relevant stakeholders outside the project following FAIR principles and in compliance with the Open Research Data Pilot (ORDP), General Data Protection Regulation (GDPR), and the needs of partners for Intellectual Property Right (IPR) protection. In the following sections, the main features are of THERMOFIRE DMP are described.

5. Data Summary

5.1. Purpose of the DMP in relation to project objectives

The goal of THERMOFIRE is the novel design, development and validation of lightweight and low-cost, bio-based and recyclable thermoplastic composites with enhanced mechanical properties and fire resistance, by incorporating additives such as natural fiber reinforcements and bio-based halogen-free flame retardants, minimizing the EU's dependence on fossil-based polymers. So, in this case, the goal will be achieved by the developing and demonstrating of 3 prototypes at TRL 5 (development on demonstration pilot), taking into account that the initial TRLs of the proposed designs are between 2 and 3 (on researching phases of concept and application formulation and validation).

Project THERMOFIRE is divided into 7 Work Packages to effectively achieve these goals. The connection between WPs is outlined in Figure 1. **WP1** will establish the functional, mechanical, environmental and operational requirements of each demonstrator in order to apply them for Aerospace, Automotive and Textile applications, including manufacturing and assembly drawings. **WP2** will develop and supply raw materials of bio-based Thermoplastics polymers (FST PA11), natural fibers and bio-based flame retardants. Although the selection of FST PA11 + biobased FR formulation will be described and scaled up to pilot scale (batches of 20 kg**). WP3** will integrate the developments for aerospace demonstrator by two processes filament winding and compression moulding, for automotive demonstrator by extrusion and for textile demonstrators. All of the properties of the demonstrators will be characterized. In **WP4** will perform the respective tests with the integration of all the results into three applications (aircraft interior seat, a battery cover for new electrical vehicle and a non-woven textile)

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WP5 will deal with the recyclability of the bio-based TP composites minimizing their environmental impact in relation with traditional petroleum-based products. In this WP the digitalization will take an important role, this data will be conveniently sorted preparing a general database which will contain every input and output present in the development. The principal task in **WP6** will be the dissemination and communication of the results of THERMOFIRE, making them available and accessible, enhancing market and business opportunities. Finally, **WP7** will ensure a smooth management of all the project activities.

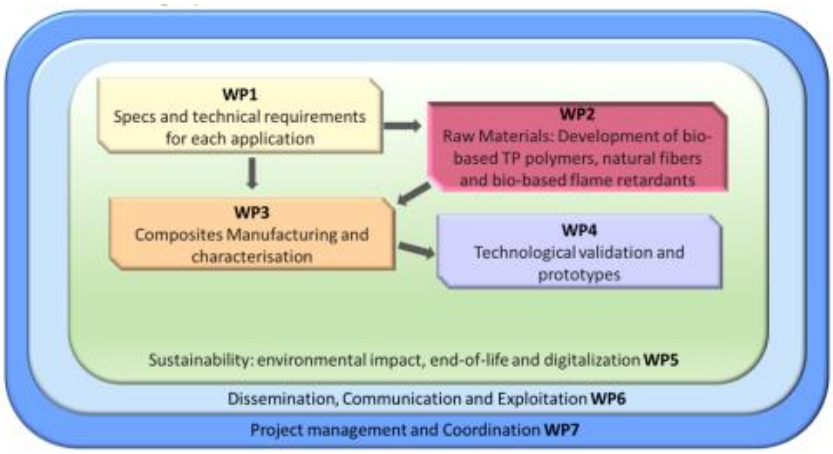

Figure 1 Connection between WPs and data, information and knowledge flow adopted from proposal.

5.2. Flow of data in relation to THERMOFIRE objectives

Data collected in **WP**1 of industrial and technical requirements for each application and specifications of the materials will be used by **WP2** to develop the synthesis of bio based polymeric composites at lab and pilot scale as well as the development of natural fibers and bio-based FR additives with its incorporation into the matrix. Data produced in **WP1** and **WP2** will be used by **WP3** to develop demonstrators for aerospace, automotive and textile applications with the corresponding formulation of each bio-based TP composites and a list of characteristic properties. **WP3** will be responsible of the scale-up of the developed formulations.**WP4** will deal with the integration of all the results from **WP3** in three prototypes (one for each application) and will perform tests for the validation of the respective demonstrator. **WP5** will study the environmental impact and the optimization of mixtures minimizing their impact. A study of the cycle of life of the product and digitalization of data by the creation of a database of the results will take place in this part of the work. **WP6** use the results of all previous WPs for broad dissemination.

The data and associated information produced by THERMOFIRE will provide the necessary scientific background for innovation and decision-making (Fig. 1). The main objectives of THERMOFIRE as described in the GAP are as follows:

Table 1: Main objectives of THERMOFIRE

Technological objectives (TOs)	
TO1.	Development of up to 100% bio-based polymeric matrices with 20% reduction in CO_2.
TO2.	Obtaining natural fibers (cellulose, flax) and making composite samples with the different Fire, Smoke and Toxicity Retardant (FST) PA11 formulation and natural fibers
TO3.	Select FST formulation (intrinsic FST PA11, FST by compounding of mix or mix of both solutions) fulfilling the FAR25 standard with the best Renewable Carbon content, by performing fire tests on composite samples.
TO4.	Development of a composite based on the selected bio-based FST polyamide 11 formulation, natural fibers to be used as housing of electric car batteries in the automotive sector.

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TO5	Development of a composite based on the bio-based FST polyamide 11, natural fibers to be used for replacing the aircraft seat shells in aerospace sector
TO6.	Development of a composite based on bio-based polymeric matrices, natural fibers and bio-based flame retardants for their use as binders in non-woven textiles.
Economic objectives (ECOs)	
ECO1.	The development of FST bio-based TP composite fulfilling the FAR 25 will open the door to large market share for bio composite (aircraft interiors for sure, but also big boat and train interiors).
ECO2.	The development of bio-based flame retardants could have also an impact on the final price of the material. It is expected that the incorporation of natural based flame retardants can contribute to the development of final low-cost products.
ECO3.	The easy processability of TPs will have considerable economical input since TPs require shorter cycle times and they do not have to be cured. As a result, and considering the high price of energy, using TPs instead of thermosets will cut down the price of the final composite (15-20%).
ECO4.	Sheet molding compound (SMC) is quite expensive (both from a raw material cost and process perspective). While for biobased TP material, technological processes such as thermoforming or injection molding can be used with a positive impact on the final cost.
Environmental objectives (ENOs)	
ENO1.	The use of bio-based polyamides (obtain from castor oil) will allow increasing the sustainability of the material, and will avoid using sources whose carbon footprints are significantly higher.
ENO2.	The use of abundantly natural resources will have lower environmental impact, since the conditions to obtain these fibers require less time and energy.
ENO3.	The use of bio-based halogen-free flame retardants will reduce the environmental impact.
ENO4.	The use of TP resins inherently increases the sustainability of the composite, since TP can be reused, reshaped and recycled.
ENO5.	Design of new methods for bio-polymer preparation with low environmental impact.

5.3 THERMOFIRE data and other outputs integration plan

THERMOFIRE Economic Objectives (ECO) and Environmental Objective 5 (ENO5) could not be achieved without careful planning of the data/information and knowledge integration.

For ensuring the proper handling, storage, sharing, and preservation of research data, here's a step-by-step guide to include data and other outputs integration in your DMP:

1. **Understand the Data and Other Outputs**: Begin by clearly understanding the types of data and other outputs that will generate in THERMOFIRE. This includes raw data, processed data, documents, code, software, reports, and any other relevant materials. In this step it is necessary to identify tasks, providing data to be integrated in DSS as well as tasks providing state of the art literature information

2. **Define Data Lifecycle Stages and specify formats:** Divide the data and other outputs into different lifecycle stages, such as collection, processing, analysis, sharing, and preservation. Then, the next step is the identification of formats and standards used for data and outputs and choosing formats that are widely accepted and ensure data compatibility and long-term accessibility.
3. **Data Collection and Storage**: Description of how data will be collected and entered into the system. This should include data capture methods, data entry protocols, and any relevant quality control procedures. Then it will be necessary to explain where and how the data will be stored during the project. Address issues such as security, redundancy, and regular backups. Mention any specific storage infrastructure, such as cloud services or local servers. So it is important to have an integration strategy: There are several integration strategies that you can use, depending on the nature of your project and the data involved. We will apply:
    - **Data warehousing**: we will create a centralized repository for all data associated with a project, allowing for easy access and analysis.

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- **ETL (extract, transform, load):** This involves extracting data from different sources, transforming it to a common format, and then loading it into a central data warehouse.
- **Plan for** uploading the THERMOFIRE data to central data warehouse, extracting, transforming, and the data,
- **Data map:** This involves naming and location of data sets and protocols as well as link to progress of work i.e., tasks and deliverables allowing all partners having a comprehensive view of all available data.

4. **Data Processing and Analysis:** Details of the tools, software, and methodologies used for data processing and analysis.
5. **Data Sharing and Access**: Specifications of how the data will be shared with collaborators, other researchers, and the public. This includes describing access controls, licenses, embargo periods, and any specific data sharing platforms or repositories you plan to use.
6. **Data Preservation**: Outline the planning for data preservation beyond the project's duration. With a specification of the repositories or archives where the data will be deposited, the expected retention period, and the methods to ensure long-term data integrity.
7. **Budget and Resources**: Estimate the budget and resources required for data management, including storage costs, software licenses, personnel, and any other expenses related to data and outputs integration.
8. **Monitoring and Review**: Explain how you will monitor the progress of your data management plan and incorporate feedback or adjustments as necessary during the project's lifespan.
9. **Dissemination and Publication**: Explain how you will publish or share your DMP with stakeholders and where it will be made publicly accessible.

5.3.1. Data map

A data map in a Data Management Plan (DMP) is a visual or textual representation of how data flows within a project. It identifies data sources, collection methods, processing stages, storage locations, data transfers, sharing, and security measures. It also outlines metadata usage, data backups, roles, and responsibilities. A data map ensures data transparency, traceability, and compliance, aiding in proper data management, protection, and preservation. It can be represented visually for better understanding and should be regularly updated to accommodate changes in data sources, processes, and policies.

In this context, a data map will be created to show relationship between different data sets with the aim to identify where data is stored, what it represents, and how it relates to other data sets.

A data map will include following information:

- Data set name: The name or identifier of the data set.
- Description: A brief description of what the data set contains and what it represents.
- Data source: The source of the data set (e.g., a database, a file, or an API).
- Data location: The location where the data set is stored (e.g., a specific table in a database, a file path, or a URL).
- Data format: The format of the data set (e.g., CSV, JSON, or XML).
- Data owner: The person or team responsible for the data set.
- Data map link: A link to a more detailed data map or a dashboard showing the progress of work (tasks and deliverables) related to the data set.

As data are coming from different tasks, a **data map** will provide an overview what data are already available in a central repository for use and reuse. It also helps in identifying data gaps and in prioritizing efforts to collect missing data.

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6. Types and formats of data generated and collected

The project will generate a variety of data, including numerical data, images, and text files (scientific publications, protocols, technical reports, book chapters).

WP1 will provide protocols on development, material property data of materials, technical requirements of each demo and data of improvements in environmental performance. Information collected in this task, along with the data from WP2, WP3 and WP4, will be used to develop the Life Cycle Assessment (LCA) of the bio-based TP composites.

WP2 will provide protocols on synthesis at lab and pilot scale of multifunctional materials, data on Manufacturing Energy assessment.

WP3 will provide data from the use cases for the formulations and characteristics of the bio-based TP composites for three demonstrators (aerospace, automotive and textile). will provide ourcome of SWOT analyses.

WP4 will provide data from the use cases including the final validation and development of the prototypes. It includes plans procedures and test results as well as requirements validations. It will be included the definition of test plan, including process, means of compliance-acceptance criteria

WP5 will provide data of cycle of life of the materials employed as well as the data from market and performance analyses and business plan. It will be included the Life Cycle Assessment (LCA) of the bio-based TP composites it will be included training and testing data and prediction models

WP 6 will provide data on dissemination and communication activities (publications, blogs, articles, the project website) as well as data on exploitation of the results.

WP7 will focus on providing the information required for the data management, quality assurance and documentation related to administrative and financial parts of the project.

Details about the types of data generated and collected are presented in the Annex in Table 2.

7. Data quality, sharing and storing within the THERMOFIRE project

Obtaining high-quality data is imperative, and data quality is defined by various dimensions, including relevance, accuracy, completeness, consistency, validity, timeliness, accessibility, interpretability, and coherence.

In the THERMOFIRE project, data quality assurance begins with a transparent research reporting process and research outputs. THERMOFIRE data producers will create detailed experimental and analysis maps (using a logical data model [8] https://www.tibco.com/reference-center/what-is-a-logical-data-model)and will provide comprehensive protocols and Standard Operating Procedures (SOPs) along with the reported data and metadata for sharing among project partners. These documents will be uploaded to the project repository.

This encompasses the sharing of protocols for the synthesis and characterization of formulations and composites, market analyses, results of the SWOT analysis.

In the case of the THERMOFIRE project, data management is a collaborative responsibility involving WP7 and all project partners. Each partner has a role to play in ensuring effective data management throughout the project's lifecycle. The goal of data management is to streamline the sharing of THERMOFIRE outputs and ensure that project results are shared easily and effectively among all partners.

The data generated within the project will be stored in a project repository or warehouse (using OneDrive). In this repository, we store:

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- **Raw data** (original, unprocessed data collected from specific sources or experiments. Raw data can come in various forms, including values, images, calculations, measurements, or observations, depending on the type of data being collected).
- **Text files** (including protocols outlining the steps, methods, and materials used in specific scientific studies or experiments. These protocols ensure consistency, reliability, and reproducibility of scientific results, allowing researchers to compare, validate, or build upon each other's work. This category also includes descriptions of experiments and all text documents or images relevant to the project).
- **Task, Deliverable, and Milestone lists**, complete with boards and Gantt charts.
- **Deliverable reports.**
- **Meeting minutes.**
- **Other relevant materials and documents.**

This comprehensive approach to data management and storage helps ensure data quality and facilitates efficient sharing and collaboration among project partners.

8. Expected size of the data

The exact size and volume of data produced during the project cannot be guaranteed at this stage, as it is anticipated to increase and undergo continuous evaluation and updates throughout the project's duration. Initial estimates indicate that several gigabytes (GBs) of data will be generated at a minimum.

For more specific details regarding the anticipated data size in the THERMOFIRE project, please refer to Annex, Table 2.

9. Utility of data outside the THERMOFIRE project

The primary objective of the THERMOFIRE project is to generate new and reliable scientific data for the development of lightweight, cost-effective, bio-based, and recyclable thermoplastic composites. These composites are intended to possess enhanced mechanical properties and fire resistance through the incorporation of additives such as natural fiber reinforcements and bio-based, halogen-free flame retardants. A key aim is to reduce the European Union's dependence on fossil-based polymers.

The data produced by THERMOFIRE will be valuable to scientists in the fields of nanomaterials and nanotechnology, as well as various stakeholders involved in material innovation, production, and addressing the challenge of dependence on fossil-based polymers. The project will yield a range of scientific research findings, including publications, contributions to conferences, datasets, and software. The overarching goal is to foster collaboration, knowledge reuse, and transparency. THERMOFIRE intends to make these results accessible to the European research community, businesses, and the general public through the following practices:

- Facilitating the transfer of science-based data into new innovations.
- Contributing to the validation, standardization, and harmonization of methods.
- Sharing new knowledge derived from the obtained data and its interpretation, unless intellectual property rights (IPR) constraints exist. This sharing is intended to inform a broader audience, including young researchers, industry professionals, and regulatory bodies.

The open access and publication of data are currently being addressed, and this aspect will continue to evolve throughout the project. Access to and publication of data may be subject to certain restrictions for individual entities involved in the project.

10. FAIR data

THERMOFIRE's data management will create a data management plan at the beginning of the project that will follow the EC guidelines to list the main datasets to be shared and the information necessary to

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implement the FAIR principles (Findable, Accessible, Interoperable, Reusable) and the OECD's Mutual Acceptance of Data (MAD) system that have been established for transparency and efficiency.

Figure 2: FAIR description

All **data handling** will take place under the principles of the following conventions:

- The EU General Data Protection Regulation 2016/679
- The EU Charter of Fundamental Rights
- The European Convention on Human Rights
- The Universal Declaration of Human Rights
- The Convention for the Protection of Individuals with regard to Automatic Processing of Personal Data
- Directive 95/46/EC (General Data Protection Regulation)

The following principles will be applied:

10.1. Making data findable (F)

To ensure that data is "findable," it's essential to provide detailed descriptive metadata and assign a unique and persistent identifier, such as a digital object identifier (DOI) [9] https://library.cumc.columbia.edu/insight/what-are-fair-data-principles. This metadata serves to place all assay data into context, explaining who collected the data, where and when it was gathered, the duration of data collection, protocols followed, experimental conditions, and the instruments used for measurements.

To achieve this, a universal metadata template will be employed to maintain consistency across the project, regardless of the data's source. Specific ontology terms will be used in the template to enhance interoperability and reusability. Ontology, in this context, refers to a formal description of knowledge in a domain, consisting of concepts and the relationships between them. The use of ontology terms helps standardize terminology within a field by providing predefined options. However, the system allows for the inclusion of additional terms if they are not present in the predefined list, which can be expanded as necessary.

10.2. Making data accessible (A)

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Accessible: by means of controlled user management (and appropriate permissions where required for certain projects that still have restrictions or other limitations on sharing), data will be "*as open as possible and as closed as necessary*" at the right time. Currently, THERMOFIRE has "opted in" to the Open Research Data Pilot (ORDP) to share data whenever available and possible but also to keep data confidential and restricted where necessary to protect IPRs, personal data, or privacy.

As mentioned above, all data will be stored in either the project management platform from our infrastructures as well as public. THERMOFIRE will make it public, indicating the owner and license, except in those cases in which it must be kept confidential (GDPR and other regulations must be fulfilled). Access to such data will be provided when associated publications are published or earlier, if possible.

Administrative data such as reports or pictures will be stored in the project management platform.

Presentations, posters, and other public data will be made available via Zenodo, allowing the use of persistent identifiers.

10.2.1. Data access conditions

The rules of data publication (project, assay, code) will be agreed upon within the Consortium and checked against Horizon EU rules.

Reports and models will be kept confidential by default. On a case-by-case basis, certain data will be selected for publication as part of the dissemination work.

There is ongoing discussion among the project partners over whether an embargo should be applied to some data; however, we are aware that research data should be made available as soon as possible.

There is no need for a data access committee (e.g., to evaluate/approve access requests for personal/sensitive data).

10.2.2. Metadata access conditions

Metadata will be provided in two forms: **human-readable and machine-readable**. In the case of machine-readable metadata, we will use standard vocabularies as a way of enhancing common semantics ([10] https://www.w3.org/2013/dwbp/wiki/Guidance_on_the_Provision_of_Metadata#Intro).

Naming standards accurately will be used for naming various data types and labels, along with the underlying metadata, where appropriate. Basic statistical and data processing procedures will be applied to standardize metadata properties for data items (e.g., data name, variables and value labels, measurement unit ranges, validated values, missing data, etc.). The RDA (Research Data Alliance) Metadata directory will be consulted whenever new naming standards are considered.

For assay data that the consortium decides to publish, the raw data and metadata will be readable by any tabulation software (such as MS Excel, Google Sheet, or LibreOffice Calc, the latter being open-source software).

10.3. Making data interoperable (I)

Interoperable: as the produced data is stored under a common umbrella (i.e., the THERMOFIRE repository), it can be combined with a variety of other project databases where project partners are involved with shared or common metadata, vocabularies, and ontology conventions applied.

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Our data will include qualified references to other data (literature data, open datasets).

10.4. Increase data re-use (R)

Re-usable: via the principles above, data will be made available on an open basis to the material innovation-community, other scientists, and the wider community, following any IP protection or restriction periods being waived or expired by mutual agreement.

All assay data generated by the project members will be supplied with metadata following templates that will be designed and agreed upon between all parties and/or ISO testing methodologies whenever applicable.

10.5. Identification of the produced and/or used data

The newly generated and/or re-used data will be discoverable through the use of a database supported search system, the wide registration and promotion of the project portal as a searchable resource, and the implementation of suitable metadata and ontologies for data curation.

It will be possible to identify and locate new generated data through appropriate search systems, database, in combination with appropriate metadata. We will upload all future published data to OpenAire/Zenodo, where it will automatically receive DOIs as unique identifiers.

10.6. Naming conventions

THERMOFIRE will use available ontologies to produce a standardized vocabulary in the database for assuring interoperability with other similar data repositories when the produced data should be named and/or labelled. These will also be used as much as possible for data collection, evaluation, quality control, and curation. Occasionally, a simple file naming convention for assay, metadata, and data will be under discussion.

11. THERMOFIRE Research Outputs

The THERMOFIRE project will evaluate its outputs based on various criteria, including the number of journal publications, book chapters, conference/workshop publications, patents, FAIR datasets, and the development of new business models. These project and research outputs extend beyond traditional data types (numerical data, images, and text files) and encompass a wide range of other valuable deliverables.

These project outputs, aside from traditional research data, may include newly acquired competencies, prototypes, videos, demonstrations, and more. They are critical results for any research project and are instrumental in advancing knowledge and innovation.

The foundation for THERMOFIRE project outputs is built on strategies, ideas, experiences gained from previous projects, and other influences. With a multitude of potential outputs, the acquisition of new competencies or the improvement of existing ones is essential for the success of this research project.

Data management is just one aspect to consider, as other research outputs generated during the project or reused from previous efforts should also be taken into account. These outputs can be both digital, such as software, workflows, protocols, and models, and physical, including new materials, reagents, samples, and more. The comprehensive range of outputs highlights the project's commitment to advancing knowledge and innovation across various domains.

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12. Costs related to making data and other research outputs FAIR and Allocation or Resources

The project budget includes the costs of management of the data platforms and they include:

THERMOFIRE Platform setup and management fees (human resources)

- For the organization of results (outputs) and sharing in all the work packages
- For organizing project management related information (list of tasks, deliverables milestones)
- For DMP management tasks

All partners are responsible for providing high quality data and protocols for sharing. AVA is in charge for describing and updating the DMP and encouraging all project partners to adopt and apply it.

THERMOFIRE project partners agreed with the Open Research Data Pilot (ORDP), which means that all data produced within the project will be made available as soon as all issues that prevent their access (IPR, confidentiality, or privacy) have been addressed (see the section on “Data access conditions” above).

The research data published in scientific journals will be open access without any costs, as associated costs will be claimed by the authoring partners as part of their requested research funding.

13. Data Security and cybersecurity

Published data will be archived for long-term preservation on OpenAIRE and Zenodo, ensuring their accessibility and sustainability. Management plans for non-published data will be further refined in subsequent versions of the Data Management Plan (DMP) to provide clear guidance on how such data should be handled at the conclusion of the project. This ongoing DMP evolution will help clarify the data's fate and ensure its proper management.

An important point we should take account it is the cybersecurity. Creating a comprehensive cybersecurity plan for protecting the data collected involves a multi-faceted approach that addresses various aspects of security.

Access Control and Authentication: the access to information will be confirmed by the controlled based on user roles and responsibilities.

Network Security: Network security controls will be configured and monitored to prevent unauthorized access as well as Firewalls, intrusion detection/prevention systems, and regular network scans will be implemented.

Data Backup and Recovery: the information will be auto-saved in order to mitigate security incidents. Regular data backup procedures will ensure recovery in the event of a breach or data loss.

Antivirus Security Management

These strategies are designed to ensure the integrity, confidentiality, and availability of data stored in the cloud while mitigating risks associated with cyber threats. The effective implementation of these measures will strengthen our cybersecurity posture and contribute to the comprehensive protection of our data assets in the cloud environment.

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14. Ethics

Any ethical or legal issues that could have an impact on data sharing will be discussed in the context of the ethics review. If relevant, ethics self-assessment as described in the guidelines How to Complete your Ethics Self-Assessment will be applied [17] EU Grants: How to complete your ethics self-assessment, Version 2.0, 13 July 2021.

15. Other Issues

Under discussion.

16. References

[1] https://www.go-fair.org/fair-principles/i3-metadata-include-qualified-references-metadata/ .

[2] https://doi.org/10.5334/dsj-2019-050

[3] http://opendatahandbook.org/guide/en/what-is-open-data/

[4] https://direct.mit.edu/dint/article/2/1-2/47/9998/The-A-of-FAIR-As-Open-as-Possible-as-Closed-as

[5] https://dmeg.cessda.eu/Data-Management-Expert-Guide/1.-Plan/FAIR-data

[6] https://www.indeed.com/career-advice/career-development/what-is-data-set

[7] https://data.europa.eu/en/training/elearning/open-data-licensing

[8]] https://www.tibco.com/reference-center/what-is-a-logical-data-model

[9] https://library.cumc.columbia.edu/insight/what-are-fair-data-principles

[10] https://www.w3.org/2013/dwbp/wiki/Guidance_on_the_Provision_of_Metadata#Intro

17. Figures

Figure 1. Connection between WPs and data, information and knowledge flow adopted from proposal

Figure 2. FAIR principles

18. Annexes

A questionnaire was sent out to the partners to collect information regarding data management and their specific requirements and existing practice.

18.1. Responses of partners

Table 2. Intention for data reuse, list of test methods and reporting templates.

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	Question 1	Question 2	Question 3	Question 4
Which institution do you represent?	**Will your institution re-use any existing data to prevent you from collecting duplicate data?**	**What will you reuse this data for?**	**What methods or tests does your institution plan to carry out as part of THERMOFIRE?**	**Does your institution use templates for electronic data reporting?**
AVA	NO	Information for optimizing the preparation integration of biobased flame retardants to achieve the adequate properties in the composites	Thermal conductivity (ASTME1530), electrical con-ductivity (several standards), mechanical performance (Flexural, tensile tests), flame retardancy (i.e. UL94)	No
ENSATEC	NO	Store and be the base of knowdlege for future research	Non-combustibility test, Single Burning Item Test (SBI), Ignitabilty test., Radiant panel test, Determination of the gross heat of combustion, flame retardancy (UL94), cone calorimetric , FAR 25.853 (a) App. F, Part I, (a)(1)(i) o (ii) E • FAR 25.853 (a) App. F, Part I, (a)(1)(iv); determination for horizontal/vertical burning rate, melting behaviour	YES
MNLT	YES	Existing data on IP brought by partners in the project (for the IP analsysis). New data for commercial exploitation	No experimental tests	YES
CTME	NO	Information for processing biobased composites	• Mechanical properties: Tensile strength (ISO 527:2012), Flexural strength (ISO 178:2019), Charpy notched impact (ISO 180:2020) • Density (ISO 1183:2019) • Thermal properties: Melt Flow Index MFI (ISO 1133:2012), differential scanning calorimetry (DSC) (ISO 11357:2021), thermogravimetric analysis (TGA) (ISO 11358:2015), dimensional stability (ISO 2796:1986)	NO

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			• Determination of water absorption (ISO 62:2008) • Resistance to chemicals (ISO 175:2000) • Morphology and fiber dispersion by using scanning electron microscopy (SEM) • Methods of exposure to laboratory light sources (ISO 4892:2017)	
CANOE	Yes, from CANOE data base compile from previous experience	The Information is going to be reuse for : - Information for optimizing the compound of TP polymer + FR + bio-charge to achieve the adequate properties in the composites. - Optimised the composition of the spinning dope used for the cellulose fiber - Use previous data (process data) to perform tape composed of natural fiber (Flax, cellulose..)	Mechanical properties: Tensile strength (ISO 527), Flexural strength (ISO 178), Charpy impact (ISO 179:2020), Heat deflection temperature HDT (ISO 75:2020);Density (ISO 1183:2019); thermal properties: Melt Flow Index MFI (ISO 1133:2012), differential scanning calorimetry (DSC) (ISO 11357:2021), thermogravimetric analysis (TGA) (ISO 11358:2015), dimensional stability (ISO 2796:1986); Determination of water absorption (ISO 62:2008);Morphology and fiber dispersion by using scanning electron microscopy (SEM)	NO
CTCR	NO	Information for optimizing the preparation integration of biobased flame retardants to achieve the adequate properties in the composites	Mechanical performance: Tear and tensile tests (several standards); Thermal properties: differential scanning calorimetry (DSC) (ISO 11357:2021). Data mining and data optimization.	No
GEOPANNEL	Yes	Geopannel plans to reuse existing data to optimize the integration of bio-based flame retardants into our manufacturing processes, in order to achieve suitable composite properties.	Within the Thermofire project, Geopannel will carry out tests and trials of thermal conductivity and thermal resistance with UNE EN 12667; Combustibility with TL1010 and FMVSS302; dimensional tests for weight UNE EN 29073-1 and Thickness (with UNE EN 9073-2) and Tensile and elongation (UNE EN 29073-3), Compression (D45 1195), adhesion (D45 1197-B), tear distribution (D41 1126), Acoustic absorption test in	Yes

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			Alpha cabin (D49 1977) and in kundt tube (ISO 10534-2)	
NTP	No	NA	mechanical performance (Flexural ISO 178:2019, tensile tests ISO 527:2012, Charpy impact ISO 179:2020) Melt Flow Index (ISO 1133) Extrusion / injection process parameters	No
POLYMERIS	No	Communication supports	NA	No
ARKEMA	NO	-	FR testings according to UL94 and LOI	No
SAFRAN	NO	Yes (internal reports in word format, sharing information with the consortium)	Resistance to impact; fire propagation; mechanical properties; assembly viability; ability to withstand stratospheric conditions and testing of the demonstrators through laboratory test based on ASTM and ISO standards	No
CRF	Yes	Product requirements and related standards	Thermal conductivity, torch test, ageing, sealing compatibility (adhesion, peeling)	Yes

Table 3. Types of electronic reporting templates, types and size of data, organization of data in different institutions.

	Question 5	**Question 6**	**Question 7**	**Question 8**
Which institution do you represent?	**Which electronic data reporting templates is your institution using?**	**What types or formats of data will be generated by your institution during the project?**	**What is the size of the data and data (file) types your institution wants to generate or reuse throughout THERMOFIRE?**	**How does your institution i.e., your department, organise research data?**

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AVA	Own made (excel, pdf)	numerical data, text files, images, tables, videos	MB-GB	Own folders in internal server and in case of THERMOFIRE, online repository
ENSATEC	Own made (excel, pdf)	numerical data, text files, images, tables, videos	MB-GB	Own folders in internal server and in case of THERMOFIRE, online repository
MNLT	Own made (excel, pdf)	numerical data, text files, images, tables,	MB	Own folders in internal server and in case of THERMOFIRE, online repository
CTME	Own made (excel, pdf)	numerical data, text files, images, tables, videos	MB-GB	Own folders in internal server and in case of THERMOFIRE, online repository
CANOE	Own made (excel, pdf)	numerical data, text files, images, tables, videos	MB-GB	i) Documents must be saved on the share folder (one line) THERMOFIRE ii) Documents are saved in internal server of CANOE iii) CANOE data base is daily saved on local and cloud server
CTCR	excel, word and pdf	numerical data, text files, images, graphics, tables, videos	MB-GB	In our own folders and documents inside a internal servel. In case of Thermofire project also an online repository
GEOPANNEL	Geopannel uses templates delivered by project for data presentation, such as word and power point, these can be exported to PDF.	Geopannel will generate numerical data, text files, images, tables and videos.	The data generated by Geopannel can range from megabytes (MB) to gigabytes (GB) in size and will cover a variety of file types such as Word, PDF, Power point or excel.	Our institution organizes research data in its own folders on an internal server. In the case of THERMOFIRE, we also use online repositories for data storage.

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NTP	Own made (excel, pdf)	numerical data, text files, images, tables, videos	MB-GB	Own folders in internal server and in case of THERMOFIRE, online repository
POLYMERIS	Own made (excel, pdf)	numerical data, text files, images, tables, videos	MB-GB	Own folders in internal server and in case of THERMOFIRE, online repository
ARKEMA	None	numerical data, text files, images, tables, videos	MB-GB	Internal data bases
SAFRAN	Own made (excel, pdf)	numerical data, text files, images, tables, videos	MB-GB	Own folders in internal server and in case of THERMOFIRE, online repository provided by the consortium
CRF	Own made	numerical data, text files, images, tables, videos	MB	Internal server

Table 4. Data availability sharing during and after the project is completed.

	Question 9	**Question 10**	**Question 11**	**Question 12**	**Question 13**	**Question 14**
	Will your data be licensed using standard reuse licenses, in line with the obligations set out in the Grant Agreement?	**What data created and/or used in the project will be made available to the public in order to enable the widest possible re-use?**	**If certain datasets cannot be shared (or need to be shared under restrictions), explain why, clearly separating legal and contractual reasons from voluntary restrictions.**	**What should be done with the data after the project?**	**What do you plan to do with the data after the project is completed?**	**If you would like to share more detailed information, please upload it here.**

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AVA	No	Public deliverables and press release. Congress, workshops and trade fairs. Scientific Papers could be done	Specific information about in house procedures or chemical routes to prepare nanoparticles and its dispersion in the matrix	Each consortium member will keep its data for a period determined by the GA or until the publication. Thereafter, the data and associated metadata will be deposited in a repository selected by the entire consortium.	Store and be the base of knowdlege for future research actions/projects	
ENSATEC	No	Public deliverables and press release. Congress, workshops and trade fairs. Scientific Papers could be done	N/A	Each consortium member will keep its data for a period determined by the GA or until the publication. Thereafter, the data and associated metadata will be deposited in a repository selected by the entire consortium.	Store and be the base of knowdlege for future research actions/projects	
MNLT	No	Public data on the added value of the project	Information on the new standards and business planning of the technological outputs will be kept secret due to	Use them for exploitation of IP (patenting possibly) and commercially, Therefore	Use them form exploitation	

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			commercial interest	data preservation needed		
CTME	NO	Public deliverables and press release. Congress, workshops and trade fairs. Scientific Papers could be done	no restrictions	Each consortium member will keep its data for a period determined by the GA or until the publication. Thereafter, the data and associated metadata will be deposited in a repository selected by the entire consortium.	Store and be the base of knowdlege for future research actions/projects	no
CANOE	NO	Public deliverables and press release. Congress, workshops and trade fairs. Scientific Papers could be done	Specific information about our process or to prepare compound and TP tape	Each consortium member will keep its data for a period determined by the GA or until the publication. Thereafter, the data and associated metadata will be deposited in a repository selected by the entire consortium.	Store and be the base of knowdlege for future research actions/projects	

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CTCR	NO	Public deliverables and press release. Congress, workshops and trade fairs. Also a webpage will be done	Internal procedures and activities needed to prepare the techical lab work	We will keep the data	Store and use of knowdlege for future research projects	/
GEOPANNEL	Yes, our data will be subject to standard reuse licenses, consistent with the obligations set out in the Grant Agreement.	Public deliverables and press release. Congress, workshops and trade fairs. We consider publishing scientifical articles.	Some data sets may not be shared due to legal or contractual reasons related to specific information about our procedures, production capabilities	Each member of the consortium will retain your data for a period determined by the Grant Agreement or until publication. After this period, the data and associated metadata will be deposited in a repository selected by the entire consortium	The data will be kept stored and will serve as a knowledge base for future actions or research projects.	
NTP	No	Public deliverables and press release. Congress, workshops and trade fairs.	Specific informations about extrudor screw profile Data co-owned with other partners on formulation composition and processing	see AVA	Store and be the base of knowdlege for future research actions/projects	
POLYMERIS	No	Public deliverables and press release. Congress, workshops and trade fairs.	Specific information on our cluster (contacts, innovation projects	Each consortium member will keep its data for a period determined by the GA or until the publication. Thereafter,	Store and be the base of knowdlege for future research actions/projects. Communication on the public results and conclusions	

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				the data and associated metadata will be deposited in a repository selected by the entire consortium.	of the project.	
ARKEMA	No	Public deliverables and press release. Congress, workshops and trade fairs. Scientific Papers could be done	Detailled characterizations of our polymers not available in the TDS	Each consortium member will keep its data for a period determined by the GA or until the publication. Thereafter, the data and associated metadata will be deposited in a repository selected by the entire consortium.	Store and be the base of knowdlege for future research actions/projects	-
SAFRAN	No	Testing campaign data won't be shared with public or published. Communication restricted to technical reviews	Information or exchange of information that could compromise future commercialization of Safran products must not be shared.	Each consortium member will keep its data for a period determined by the GA or until the publication. Thereafter, the data and associated metadata will be deposited in a repository selected by the	Store and be the base of knowdlege for future research actions/projects	

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				entire consortium .		
CRF	No	Presentation of the final demonstrato r via public deliverables and press release.	Materials data (resin, reinforcement s, additives) are developed within the project and are knowledge of some Partners. CRF is "owner" only of the final product.	n.a.	Development os similar components for new vehicles	

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