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THERMOBAT

A Ferrosilicon Latent Heat Thermophotovoltaic Battery

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Data management plan

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Dissemination Level		
PU	Public	
SEN	Confidential, only for members of the consortium (incl. the Commission Services)	X

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Abstract

This deliverable describes the initial Data Management Plan (DMP) for THERMOBAT project. It addresses Project administration data collected as part of the execution and management of a disruptive research and development of a ferrosilicon latent heat thermophotovoltaic battery.

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1. DATA MANAGEMENT PLAN

1.1 Introduction

The THERMOBAT project, funded by the European Commission (EC) under the Horizon Europe program is inherited from the previous AMADEUS project, funded by the EC under the Horizon 2020 program. This previous project had an ambitious and successful strategy for data management, following the guidelines[1] described in the so-called Open Research Data Pilot (ORD pilot). This pilot was part of the Open Access to Scientific Publications and Research Data Program in H2020[2] and addressed aspects like research data quality, sharing and security and aimed to improve and maximise access to and re-use of research data generated by Horizon 2020 projects. It took into account the need to balance openness and protection of scientific information, commercialisation and intellectual property rights (IPR), privacy concerns, security as well as data management and preservation questions.

In view of the success of the data management plan (DMP) followed in AMADEUS, the THERMOBAT project will continue its actions in data management. This report will describe these actions, including a detailed overview of the types of data that will be generated or gathered during the project, the standards that will be used, the ways how the data will be exploited and shared for verification or reuse, and how the data will be preserved. In addition, the THERMOBAT DMP must ensure the project partners' research data are findable, accessible, interoperable and reusable, defined as FAIR principles.

1.2 Purpose of the data collection/generation

THERMOBAT DMP will be set according to Article 17 of the Grant Agreement "Communication, dissemination, open science and visibility". Project participants must deposit their data in a research data repository and take measures to make the data available to third parties. The third parties should be able to access, mine, exploit, reproduce and disseminate the data. This should also help to validate the results presented in scientific publications. In addition, Article 17 states that participants will have to provide information, via the repository, about tools and instruments needed for the validation of project outcomes.

On the other hand, Article 17 incorporates the obligation of participants to "…e*nsure open access to peer-reviewed scientific publications relating to their results…*" as well as to "*manage the digital research data generated in the action ('data') responsibly, in line with the FAIR principles…*". In line with this, the THERMOBAT consortium will decide what information is made public according to aspects as potential conflicts against commercialization, IPR protection of the knowledge generated (by patents or other forms of protection), meaning a risk for obtaining the project objectives/outcomes, etc.

THERMOBAT consortium will use Microsoft TEAMS as private repository to share documents among partners in a fast and simple way and ZENODO (an OpenAIRE and CERN collaboration) as open repository for open-access purposes. Motivations to use ZENODO are:

[1] http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/oa_pilot/h2020-hi-oa-data-mgt_en.pdf

[2] http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/oa_pilot/h2020-hi-oa-pilot-guide_en.pdf

- It allows researchers to deposit both publications and data, while providing tools to link them.

- In order to increase visibility and impact of the project the THERMOBAT community has been created in ZENODO, so all beneficiaries of the project can link the uploaded paper to the Community.

- ZENODO assigns all publicly available uploads a digital object identifier (DOI) to make the upload easily and uniquely citable.

- The repository allows different access rights.

All the above makes ZENODO a good choice as a unified public repository for all foreseen project data (presentations, publications, images, videos and measurement data) from THERMOBAT.

1.3 Objectives of THERMOBAT project

THERMOBAT will develop a Power-to-Heat to Power Storage (PHPS) system using the Latent Heat Thermophotovoltaic (LHTPV) technology. Patented by UPM, LHTPV systems store electricity coming from variable renewable energy sources at very low costs (< 10 €/kWh) in the form of latent heat in ultra-high-temperature phase change materials (PCM) and converts it back to electricity and lowgrade heat (< 70 ºC) on-demand using thermophotovoltaics (TPV). The LHTPV battery will use a new kind of ferrosilicon-based PCM for thermal storage: the eutectic alloy Fe26Si-9B (FeSiB for short). Developed by the NTNU in the previous AMADEUS project, this PCM uses abundant, recyclable, non-toxic, and low-cost materials, exhibits a remarkably high latent heat over 1 MWh/m^3 (one cubic meter can store more than twice the energy than a Li-ion battery) and has a high melting temperature (~ 1200 ºC) that perfectly matches the use of TPV generators. TPV enables a highly efficient (32 % demonstrated, and 40-50 % practically attainable) heat-to-power conversion without requiring the complex heat exchangers and heat transfer fluids that are needed in conventional systems based on turbogenerators, ultimately enabling the development of relatively small, silent, modular, and scalable systems.

The specific objectives of the project are:

- **Objective 1**: new route for manufacturing FeSiB PCMs from raw and waste materials at costs lower than 3 €/kWh

- **Objective 2**: 100 kWh Heat Storage Box with > 1 MWh/m^3 withstanding > 100 thermal cycles

- **Objective 3**: 1 kW TPV generator with an efficiency > 20 % and power density > 1 W/cm^2 at 1200ºC

- **Objective 4**: A 100 kWh LHTPV demonstrator with electric-RTE > 10 % and global-RTE > 70%

- **Objective 5**: LHTPV demonstrator tested in a relevant environment during > 1000 hours generating > 2 MWh

1.4 Dissemination policy

The THERMOBAT project is pioneering research that is of key importance to the energy storage industry. Effective exploitation of the research results depends on the proper management of intellectual property. Therefore, the THERMOBAT consortium will follow the strategy outlined in (Figure 1). When the research findings result in a ground-breaking innovation, the members of the consortium will consider two forms of protection: to withhold the data for internal use or to apply for a patent in order to commercially exploit the invention and have in return financial gain. In the latter case, publications will be therefore delayed until the patent filing. On the contrary, if the technology developments are not going to be withheld or patented, the results will be published for knowledge sharing purposes.

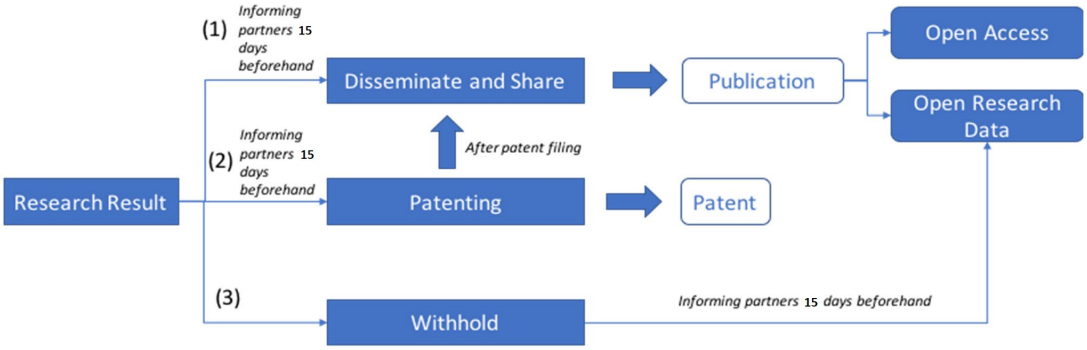

Figure 1. **Schema on the dissemination policy of the Consortium.**

The scientific and technical results of the THERMOBAT project are expected to be of maximum interest for the scientific community. Through the duration of the project, all intended disseminations or protections must be noticed 15 days in advance in order to get the permission or objection from the Consortium. Once the relevant protections (e.g. IPR) are secured, the THERMOBAT partners may disseminate (subject to their legitimate interests) the obtained results and knowledge to the relevant scientific communities through contributions in journals and international conferences in the field of Materials Science, Energy or Physics.

1.5 Types, formats, size and origin of data generated/collected

The THERMOBAT DMP applies to two types of data:

- The data, including associated metadata, needed to validate the results presented in scientific publications (underlying data);
- Other data, including associated metadata, to be developed by the project. This refers to specifications of the THERMOBAT system and the services it supports, the datasheets and performances of the technological developments of the project, the field trial results with the KPIs (Key Performance Indicators) used to evaluate the system performances,

meeting presentations, demonstrator videos, pictures from set-ups, lab records, schemes, technical manuals, among others.

The format of the data generated will be mainly electronic, but some primary data records can be also found handwritten as an example when beneficiaries use lab notes in a daily basis. THERMOBAT project will ensure that all electronic files follow the FAIR policy as explained later. The main format of electronic data in order to ensure the accessibility to data will be any of the included in the IANA media types[3].

Expected size of data generated will be reasonable according to the normal practices of the beneficiaries' research. Nevertheless, the Consortium does not expect to deal with large files.

Regarding the origin of data, the majority of them will come from software used for simulations, experimental setups and equipment used.

1.6 Data utility

Open research data from THERMOBAT will allow that other researchers can make use of that information to validate the results, thus being a starting point for their investigations, as expected by the EC through its open access policy.

1.7 Consortium awareness

The DMP is used by THERMOBAT partners as a reference for data management (providing metadata, storing and archiving) within the project each time new project data is produced.

The project partners are introduced to the DMP and its use as part of WP1 activities. Relevant questions from partners will also be addressed within WP1. The workpackage will also provide support to the project partners on using either Microsoft TEAMS or Zenodo as the data management tool, depending on the case.

The coordinator will ensure the research open data policy by verifying periodically the information uploaded to ZENODO repository and THERMOBAT community.

2. FAIR DATA

With the endorsement of the FAIR principles and its incorporation into the guidelines for DMPs in Horizon Europe, the FAIR principles hereby serve as a template for a full-lifecycle data management. Although the FAIR principle does not serve as an independent lifecycle data model, it assures that the most important components of a full life cycle model is covered.

As stated before our Consortium will use ZENODO repository for Open Research data purposes since Zenodo facilitates linking publications and underlying data through persistent identifiers

[3] http://www.iana.org/assignments/media-types/media-types.xhtml

and data citations. Therefore, the FAIR data policy we are following is that established by this repository[4].

2.1 Making data findable, including provisions for metadata

2.1.1 Discoverability: metadata provision

Metadata are created to describe the data and aid discovery. According to ZENODO repository all metadata is stored internally in JSON-format according to a defined JSON schema. Metadata is exported in several standard formats such as MARCXML, Dublin Core, and DataCite Metadata Schema (according to the OpenAIRE Guidelines).

Beneficiaries will complete all mandatory metadata required by the repository and metadata recommended by the repository but mandatory for THERMOBAT Consortium and could provide additional metadata if appropriated. A general overview of metadata is outlined in Table 1.

Metadata	**Category**	**Additional Comments**
Type of data	Mandatory	
DOI	Mandatory	If not filled, ZENODO will assigned an automatic DOI. Please keep the same DOI if the document is already identified with a DOI.
Publication Date	Mandatory	
Title	Mandatory	
Authors	Mandatory	
Description	Mandatory	A description of the dataset including the procedures followed to obtain those results (e.g., software used for simulations, experimental setups, equipment used, etc.).
Keywords	Mandatory	Frequently used keywords, plus THERMOBAT.
Access rights	Mandatory	Open Access. Other permissions can be considered when appropriated.
Terms for Access Rights	Optional	Licenses Creative Common will be detailed here. THERMOBAT will open the data under Attribution, ShareAlike, Non Commercial and No Derivatives Licences.
Communities	Mandatory	THERMOBAT community in Zenodo
Funding	Mandatory	European Union (EU), HORIZON-EIC-2021-TRANSITION-CHALLENGES-01, Grant Nº 101057954, THERMOBAT.

Table 1. Information on metadata generated at ZENODO.

[4] http://about.zenodo.org/policies/

2.1.2 Identifiability of data

Beneficiaries will maintain the DOI when the publication/data has already been identified by a third party with this number. Otherwise ZENODO will provide each dataset with a DOI.

2.1.3 Naming convention

THERMOBAT does not establish a naming convention for uploading data to the repository. Since mandatory metadata in ZENODO repository include a description of the dataset, we ensure third parties will access data easily by describing properly the dataset. Likewise, our policy of not changing data names will allow data to be consistent and traceable in each author's local back-up devices.

2.1.4 Approach towards search keyword

ZENODO allows for introducing keywords for each dataset. Each author will introduce relevant keywords and all dataset generated by the Consortium will be also identified with the keyword THERMOBAT.

2.2. Making data openly accessible Types of data made openly available

2.2.1. Types of data made openly available

The underlying data related to the scientific publications will be made publicly available by means of ZENODO. This will allow that other researchers can make use of that information to validate the results, thus being a starting point for their investigations, as expected by the EC through its open access policy.

Since a huge amount of data is generated in a European project as THERMOBAT, the Consortium will make a selection of relevant information, disregarding that not being relevant for the validation of the relevant published results.

Beneficiaries will be able to choose, additionally to the data underlying publications, what other data they make available in open access mode. The reason of this optionality is based on ensuring a proper development of the research since a project that is looking for a novel energy storage system could experience some exploitation difficulties in a medium-term whether certain data have been open to third parties.

For "other data" (those not linked to a paper) the beneficiary must communicate to the rest of the consortium its intent to open the data through ZENODO according to Article 17 of Grant Agreement: "*A beneficiary that intends to disseminate its results must give at least 15 days*

advance notice to the other beneficiaries (unless agreed otherwise), together with sufficient information on the results it will disseminate".

2.2.2. Methods or software tools needed to access the data

All our data are openly accessible since we used standard formats according to IANA media types.

2.2.3. Deposition of data and associated metadata, documentation and code

As explained in 1.2 we will use ZENODO repository for the purpose of data, metadata and documentation deposition.

2.3. Making data interoperable

Interoperability means allowing data exchange and re-use between researchers, institutions, organisations, countries, etc. (i.e. adhering to standards for formats, as much as possible compliant with available (open) software applications, and in particular facilitating re-combinations with different datasets from different origins.

THERMOBAT Consortium ensures the interoperability of the data by using data in standard formats according to IANA media types and using ZENODO repository with a standardization JSON scheme for metadata.

2.4. Increase data re-use (through clarifying licenses)

Data (with accompanying metadata) will be shared no later than publication of the main findings and will be in-line also in ZENODO. The maximum time allowed to share underlying data is the maximum embargo period established by the EC, six months.

THERMOBAT open research data will free to re-use under creative Commons Licences: Attribution, ShareAlike, Non Commercial and No Derivatives.

Data will be accessible for re-use without limitation during and after the execution of THERMOBAT project. After the end of the project, data will remain in the repository. Publications and/or other data related with the project but generated after its deadline will be also uploaded.

3. ALLOCATION OF RESOURCES

THERMOBAT will use ZENODO to make data openly available so there is no cost for the infrastructure. The cost of personnel devoted to the management of the data is considered to be charged under the Program.

Each beneficiary will devote its own personnel resources to upload data to ZENODO and follow the instructions contained in this document. The Coordinator will name a person responsible to verify and control data opened by partners ensuring that the policy described in this document will be fulfilled.

4. DATA SECURITY

ZENODO counts with a technical infrastructure that ensures data security and long term preservation. The interested reader can check the terms at http://about.zenodo.org/infrastructure/.

5. ETHICAL ASPECTS

There are no ethical aspects affecting to THERMOBAT research so we consider that all data are out of ethical considerations.

On the other hand, in order to guarantee that no sensitive data are archived without the consent of the Consortium, partners will apply the good practice of communicating any kind of disclosure 15 days beforehand.