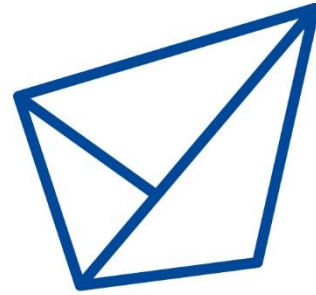# *Data Management Plan*
WP4 (D4.2)

LEDtech-GROW

LED TECHNOLOGY BASED ON BISMUTH-SENSITIZED Eu^{3+} LUMINESCENCE FOR COST-EFFECTIVE INDOOR PLANT GROWTH

PROGRAM-PROMIS-2024-2025

Grant Agreement: 10412

Deliverable 4.2

Data Management Plan

Version: 1

Contractual Date Delivery: 02/07/2024

Project Deliverable Information Sheet

LEDtech-GROW Project	Project Ref. No. 10412
	Project Title: *LED technology based on bismuth-sensitized Eu³⁺ luminescence for cost-effective indoor plant growth*
	Call: Program PROMIS 2023
	Starting Date: 03/01/2024
	Duration: 24 months
	Project Website: https://ledtechgrow-promis.org/
	Deliverable No.: D4.2.
	Deliverable Type: Document
	Month of delivery: 6
	Contractual Delivery Date: 02/07/2024
	Actual Delivery Date: 01/07/2024
	Principal investigator: Dr. BOJANA MILIĆEVIĆ
	Abstract: This document outlines a plan for managing the data generated or collected throughout the project activities. It comprises the key features outlined in the European Commission Guidelines for H2020 and the data management strategy that will be applied to all datasets generated by the project.

Document Control Sheet

Document	Title: Data Management Plan.docx
	Version 1
	Distributed to LEDtech-GROW Participants
Authorship	Written by Bojana Milićević
	Contributed and reviewed by Sanja Kuzman
	Approved by Bojana Milićević

Executive Summary

The presented document constitutes deliverable D4.2 – Data Management Plan (DMP) of the LEDtech-GROW project. It is a public document, delivered in the context of WP4 - *Management, communication, dissemination, and exploitation,* Task 4.2 - *Dissemination, communication, and exploitation of knowledge.*

This document presents the first release of DMP foreseen in the framework of the LEDtech-GROW project. The main purpose of this Deliverable is to provide a plan for managing the data generated and collected during the Project with a focus on open access & sharing. Specifically, the DMP describes the data management life cycle for all datasets collected, processed, and generated through the project activities. In addition, the DMP specifies whether data will be shared/made open and how and what methodology and standards will be applied.

The content of the DMP is complementary to other official documents that define obligations under the Grant Agreement and shall be considered a living document and as such will be the subject of periodic updating as necessary throughout the lifespan of the Project.

This document was prepared according to the template provided by the European Commission (EU) Guidelines on Data Management in Horizon 2020 [1], with adaptations.

Table of Contents

Abbreviations and Acronyms

Explanation

[DMP]	Data Management Plan
[DOI]	Digital Object Identifier
[EU]	European Commission
[FAIR data]	Findable, Accessible, Interoperable, Re-usable data
[Gold Open Access]	Open access publishing (gold open access) means that an article is immediately provided in open access mode on the publisher or journal's website. Some publishers charge Article Processing Chargers (APCs) to make articles open.
[Green Open Access]	Self-archiving (green open access) means that a published article or the final peer-reviewed the manuscript is archived (deposited) in an online repository before, alongside, or after publication. In some cases, the author can delay access to the article (embargo period). H2020 rules state that embargo periods cannot exceed six months, except for publications in social science and humanities where the maximum embargo period is twelve months.
[LEDtech-GROW]	Acronym of the Project Titled "*LED technology based on bismuth-sensitized Eu^{3+} luminescence for cost-effective indoor plant growth*"
[PAR]	Photosynthetically active radiation (400–700 nm of wavelength), an essential part of the light spectrum which typically drives photosynthesis more efficiently at the red and blue regions of the spectrum
[PROMIS 2023]	The Program for Excellent Projects of Young Researchers (PROMIS) is a program of the Science Fund of the Republic of Serbia intended of excellent projects for young researchers in the early phase of their careers
[R&D]	Research and development
[VinaR]	VinaR, i.e. Vinca Repository is a joint digital repository of all laboratories and departments in Vinča Institute of Nuclear Sciences, University of Belgrade. VinaR provides open access to the publications, as well as other outputs of the research projects implemented in these institutions.
[VINS]	"Vinča" Institute of Nuclear Sciences – National Institute of the Republic of Serbia, University of Belgrade
[WP]	Work package
[Zenodo]	Zenodo is a catch-all research data repository that enables researchers, scientists, EU projects, and institutions to share research results, make research results citable and search and reuse open research results from other projects. Zenodo repository is harvested by the OpenAIRE portal and hosted by the CERN cloud infrastructure.

1. Introduction

LEDtech-GROW – "LED technology based on bismuth-sensitized Eu^{3+} luminescence for cost-effective indoor plant growth" is a Science Fund of the Republic of Serbia funded project (Program PROMIS 2023, Grant Contract No. 10412) coordinated and completely executed by "Vinča" Institute of Nuclear Sciences – National Institute of the Republic of Serbia, University of Belgrade (VINS). The project will run from January 3rd, 2024 to January 2nd, 2026.

LEDtech-GROW is a highly ambitious and innovative project that aims to achieve a breakthrough in modern, efficient, and moisture-resistant plant-grow-targeted LED illumination as a key solution for successful future artificial indoor agriculture production. LEDtech-GROW offers innovation in the field of LEDs that entirely satisfy the needs of plants and cannot be achieved with any currently available LED technology. This project will develop inorganic phosphors that convert as much electrical energy as possible into a Photosynthetically Active Radiation (PAR) spectrum of plant photoreceptors, which differs from one required for general lighting. Particularly, double- and triple-wavelength-emitting phosphors increase light output for cryptochrome and phytochrome photoreceptors while ensuring high color quality will be produced. The fundamental concept of inner-particle energy transfer between Bi^{3+} and Eu^{3+} ions significantly contributes to developing plant-grow-targeted LEDs. Moreover, the LEDtech-GROW project will focus on designing and fabricating highly efficient plant-grow-targeted LEDs based on bismuth-sensitized Eu^{3+}-activated single-component phosphors for the whole PAR spectrum.

LEDtech-GROW project comprises two technical work packages as follows:

❖ WP1 Design, synthesis, and characterization of plant-grow-targeted phosphors

❖ WP2 Design, fabrication, and LEDs performance

Two non-technical work packages ensure the facilitation of the technical work and coordination of all the work packages, dissemination, and communication of the project results. These work packages consist of the following:

❖ WP3 Professional development of young and early-stage researchers

❖ WP4 Management, communication, dissemination, and exploitation

This document has been prepared to describe the data management life cycle for all data sets that will be collected, processed, or generated by the LEDtech-GROW project. It is a document outlining how research data will be handled during the Project, and after the Project is completed. It describes what data will be collected, processed, or generated and what methodologies and standards will be applied. It also defines if and how this data will be shared and made open, and how it will be curated and preserved.

2. Open Access & Sharing

Open access can be defined as providing online access to scientific information that is free of charge to the reader and that is reusable. In the context of research and development, open access typically focuses on access to "scientific information", which refers to two main categories:

❖ Peer-reviewed scientific research articles (published in academic journals) and

❖ Scientific research data (data underlying publications or raw data).

In accordance with Articles 28 and 29 of the Contract for the financing and realization of the project between the Science Fund of the Republic of Serbia and "Vinča" Institute of Nuclear Sciences – National Institute of the Republic of Serbia, University of Belgrade, No. 5594/2023 (Contract, from 04.12.2023.) and recommendations on "Open Access to research data", exploitation and intellectual property rights requirements, all LEDtech-GROW's team members will bind to this document and follow the guidelines and procedures described here.

Thus, we refer to the Contract articles 28 and 29 about open access to research data:

> **"Article 28":** *Publication of papers in leading scientific journals, including open science journals, and presentation at leading scientific conferences is suggested.*
> **"Article 29":** *In order to increase the quality and visibility of the results of scientific work, the Principal Investigator is obliged to ensure that the research within the Project is carried out in accordance with the principles of open science, and that accordingly:*
> *1. at any time during the duration of the Project, as well as at least one year after the end of the Project, provide interested parties with access to the results of the Project, in accordance with good academic practice, intellectual property rights protection, and data protection;*
> *2. ensure that the primary research data collected during the implementation of the Project are prepared, systematized, structured, and electronically formatted. It is recommended that open access to such data be provided in accordance with the law governing the field of science and research, and according to the recommendations and guidelines of the Science Fund.*

Benefits of open access:

❖ Unprecedented possibilities for disseminating and exchanging information due to the advent of the Internet and electronic publishing.

❖ Wider access to scientific publications and data including creation and dissemination of knowledge, acceleration of innovation, fostering collaboration and reduction of effort duplication, involvement of citizens and society, contribution to returns on investment in R&D, etc.
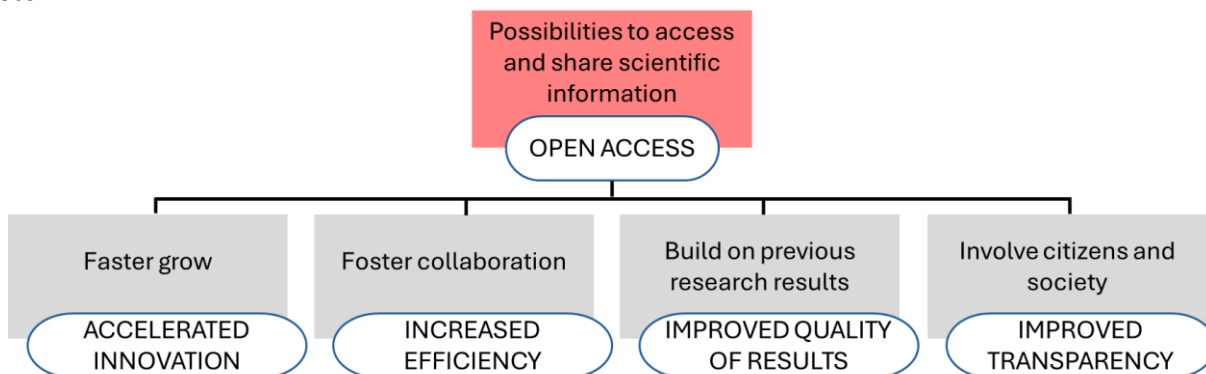

Figure 1. Open Access benefits.

The Data Access and Sharing Plan includes several aspects to be identified. The data resulting from the project will be available for educational, research, and non-profit purposes. Also, according to the exploitation and dissemination plan of the Project, the outcomes will be accessible to the public. These plans may include publication of the results in waves during the project or at the end of it. In more detail, these issues regarding the data access and sharing plan are presented below.

3. LEDtech-GROW Project Website - storage and access

LEDtech-GROW project website is used for storing public documents related to the project and dissemination. The LEDtech-GROW website will be live throughout the project and for at least a year after it ends. The website contains mainly public deliverables, brochures, posters, presentations, scientific papers, newsletters, magazine articles, videos, photos, etc. The project website will not include confidential deliverables when the main exchange of these data will be among the Project team members.

The website https://ledtechgrow-promis.org/ was launched during the early Project stage and has regular updates. It is a dynamic and interactive tool to ensure clear communication and wide dissemination of project news, activities, and results. The website is of primary importance due to the expected impact on the target audiences. It was designed to give quick, simple, and useful information. The website is regularly updated with news and events related to the LEDtech-GROW Project, press releases, magazine articles, open-access scientific papers, etc. The website is available in English.
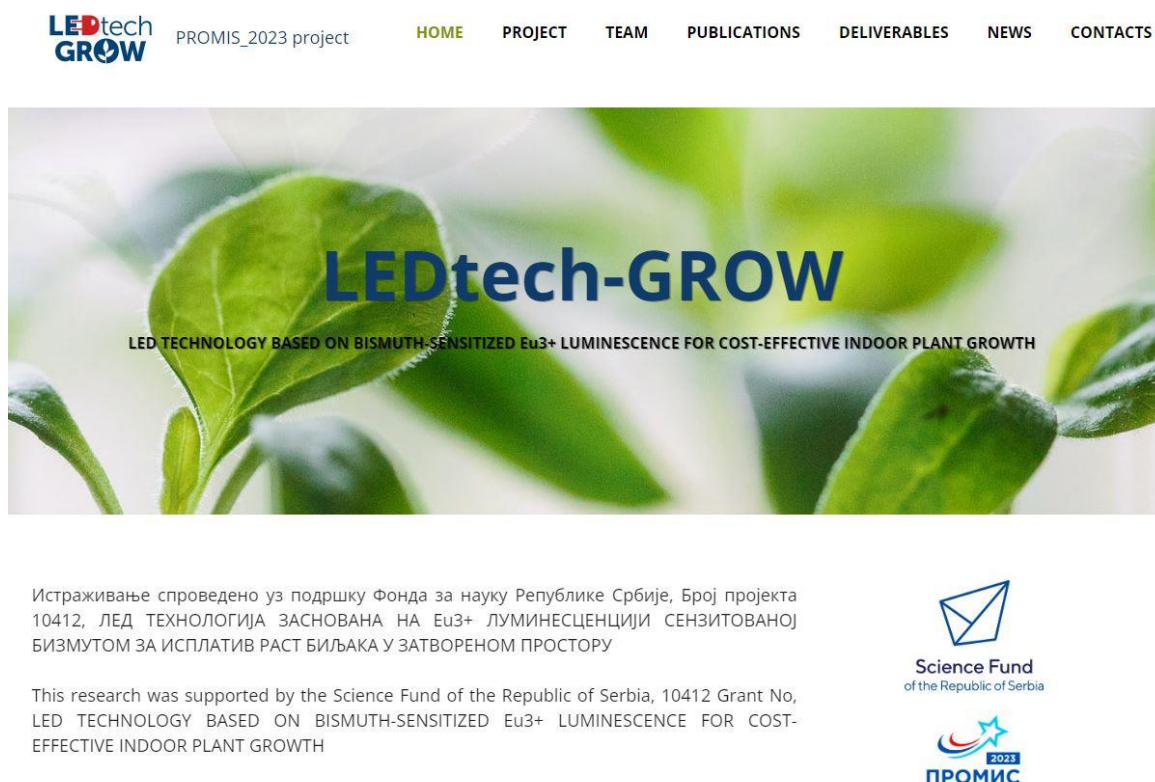

Figure 2. LEDtech-GROW project website.

4. Data Summary - Purpose, Features and Principles

The purpose of the DMP is to analyze the main data collected and generated in the frame of the LEDtech-GROW project and provide a strategy for managing those data to optimize access to and reuse the same. It will cover the complete research data lifecycle. In particular, the document describes the types and formats of research data that will be generated or collected, how the research data will be preserved, or what parts of the datasets will be shared for verification or reuse.

The data generated by LEDtech-GROW can be related to the research data lifecycle as follows. In the first step, raw data will be generated/collected from lab work, simulations, analysis, and measurement that will be processed and worked into more suitable and usable forms (reports, publications, data tables, images, etc.). The second step is to preserve that data, which implies appropriate naming rules and metadata schemes. The final, third step will be applied to define which datasets will be made accessible (share and reuse).

Due to its nature, the DMP of LEDtech-GROW is not expected to be a fixed document, it will rather evolve during the project's lifetime and, therefore, it will be reviewed and updated if necessary. Situations that oblige a revision of the DMP are (but not limited to): new data, changes in the project policies (innovation potential, decision to file a patent, etc), changes in the project composition, etc.

This first version of the document includes preliminary information on the datasets to be produced or collected by the project, their nature, and some of the specific conditions linked to those datasets (at least, the ones that are identifiable to date). The next versions of the DMP will be amended or corrected where needed. An updated version of this list will be provided at the end of the project.

> Scientific data and publications produced during the project will be available through open access (data and publications) or subscription (publications) schemes. The papers will primarily target journals categorized as M21 in the Republic of Serbia and offering open access publication (e.g., Advanced Optical Materials, Advanced Functional Materials, Physical Review series, Nano Letters, Nano Research, Nanoscale, Optical Materials, and RSC Advances, and MDPI publisher). Open-access publications will be available through the project website (https://ledtechgrow-promis.org/), and the Optical Materials and Spectroscopy Group's website (https://omasgroup.org). They will also be deposited on Zenodo, a catch-all repository for research provided by CERN, (an OpenAIRE partner), completely free to access and does not require an account, and the VinaR repository of the Institute of Nuclear Sciences "Vinca"- Nacional Institute of the Republic of Serbia, University of Belgrade. The data generated during the project (measurement, simulations, etc.), and the necessary accompanying information, will be publicly accessible on Zenodo after publication in peer-reviewed journals (both open access and subscription).

5. Data Summary – LEDtech-GROW Data Sets

The datasets collected/generated by LEDtech-GROW can be categorized into 2 main types/categories: **I. Research Data and Metadata and II. Publications and other dissemination materials**. In this regard, and depending on the dataset type, there are several standards and guidelines the project needs to be aware of and follow, which will be addressed below.

Per principle and following the Contract (article 29), datasets linked to exploitable results will not be put into the open domain if they compromise commercialization prospects or have inadequate protection. The rest of the datasets will be deposited in an open-access (Zenodo), and VinaR repositories.

Figure 3. Zenodo and VinaR repositories will be used for stored datasets.

The confidential datasets linked to exploitable results will be dissected by the PI and project management staff, with the help of the support structures (e.g., the Office for the Project Management of the Vinca Institute of Nuclear Sciences and the Library). The analysis and decision on these matters will follow well-known criteria in EU Horizon projects shown in *Figure 4* [2, 3] and will be in accordance with Article 29. In practice, for any of the project findings that are highly innovative or have a high potential for commercialization, two actions will be taken: 1) keep the data for internal use, or 2) provide proper protection (e.g., file a patent application, register a trademark, etc.) and begin technology valuation efforts to find a potential licensee. All confidential data that have a high possibility for commercialization will be stored on the ASANA web platform, and available only for team members of LEDtech-GROW. In this context, additional measures will be taken, namely the application of non-disclosure agreements whenever information is to be shared outside the project team or publication delay so that patent applications can be filled. Otherwise, the results will be made available for Open Access by using online repository services or publishing in journals adhering to Open Access policies (green or gold), dissemination through the project's website and the Optical Materials and Spectroscopy Group website.
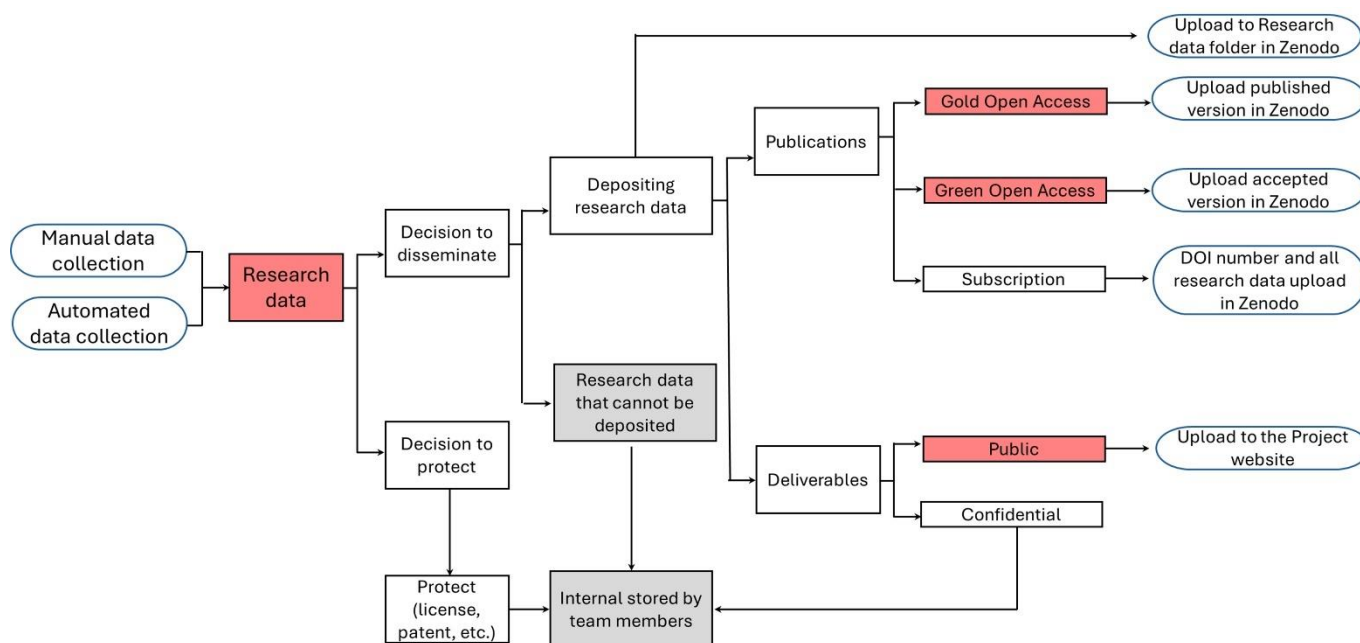
Figure 4. The process of uploading datasets in the wider context of dissemination and exploitation [2, 3].

The data generated refers to the experimental and technical data generated/collected during the project execution. These datasets will be generated mainly as spreadsheets, tabulated text files, image files, and programming code. Regarding dataset size, at this point of the project, we cannot estimate the total amount of data generated during the project. Appendix A summarizes the first version of datasets that LEDtech-GROW aims to generate, as well as their accessibility. An updated version of this list will be provided at the end of the project.

LEDtech-GROW is seeking to maximize access to research data generated by the project and will manage data following the EC guidelines for projects participating in FAIR Data Management. The FAIR data management implies that research data should be Findable, Accessible, Interoperable, and Reusable [3, 4].

Making data findable

LEDtech-GROW will upload all our public datasets and deliverables as well as scientific publications to the Zenodo repository. This will be the main tool to make our research data findable. All uploads will be enriched with standard Zenodo metadata, including Grant Number and Project Acronym. The metadata of each record is indexed and searchable directly in Zenodo's search engine immediately after publishing. Zenodo also provides version control and assigns DOIs to all uploaded metadata of each record [5].

Making data accessible

All public datasets and scientific publications will be uploaded to Zenodo and made openly available, free of charge. In addition, all open-access publications will be uploaded to the VinaR repository, and deliverables will be uploaded to the Project website. Publications and underlying data sets will be linked by using the persistent identifiers (DOI versioning). Metadata is publicly accessible and licensed under the public domain. No authorization is ever necessary to retrieve it. Data sets and metadata will be retained for the repository lifetime [5]. This is currently the lifetime of the host laboratory CERN, which has an experimental program defined for the next

20 years at least. Metadata is stored in high-availability database servers at CERN, which are

separate from the data itself. Data sets with a dissemination level of "confidential" will not be shared due to privacy concerns. Potentially, some datasets might be restricted due to protection for commercial exploitation. If such cases arise during the project, this will be informed in the final version of the DMP.

The data will be available through www.zenodo.org, and hence accessible using any web browsing application.

Making data interoperable

Zenodo offers the export of metadata to other formats such as Dublin Core, MARCXML, BibTeX, CSL, DataCite, and export to Mendeley [5]. The data record of metadata will utilize the vocabulary applied by Zenodo that follows FAIR principles. Data sets and metadata use a formal, accessible, shared, and broadly applicable language for knowledge representation. Reference to any external metadata is done with a resolvable URL.

Reusable data

The LEDtech-GROW project will enable third parties to access, exploit, reproduce, and disseminate (free of charge for any user) all public data sets. Data sets and metadata are richly described with numerous accurate and relevant attributes. Furthermore, metadata are released with a clear and accessible data usage license. Data downloaded by the users is subject to the license specified in the metadata by the uploader. Metadata are associated with detailed provenance, i.e. all data and metadata uploaded are traceable to a registered Zenodo user. At least, metadata meets domain-relevant community standards, one of the broadest cross-domain standards available.

Summary of the data format generated/collected by LEDtech-GROW project members and recommended file formats for sharing, re-use, and preservation:
- Documents/Reports/Publications: ".pdf", ".doc/.docx"
- Datasets: ".xls/.xslx", ".dat", ".txt"
- Digital image data: ".png", ".jpg/.jpeg", ".tif/.tiff"
- Code: ".m", ".nb", ".vi"
- Other: ".zip", ".rar"

A complete detailed list of expected data type formats in LEDtech-GROW is **in Annex 1.**

The data collection generated by LEDtech-GROW will be used, in the first instance, by the project members and VINS, subsequently; the results/findings/developments obtained by the LEDtech-GROW project may be useful to scientific or private entities.

The data sets can be identified and detailed as follows (according to FAIR Data principles) (presented by material type data set).

This table will be used for each dataset

Data set reference and name	*e.g., Materials_DataSet;* *e.g., LED-probes_DataSet;*
Data set description	The metadata will be recorded in a *.xls/.xlsx* file comprising the data collection, describing the following key aspects: - *Project name* - *Funding source* - *Data researcher* - *Sample name* - *Sampling procedure* - *Data collection instruments* - *Substantive, temporal, and geographic coverage of data collection* - *Data source(s)* - *Variables* - *Technical information on files* - *Citations to related publications (if applicable)* - *Technical information on files, e.g., information on file formats, file linking*
Metadata and Standards	Metadata: The metadata generated for each data set or image will be organized according to the corresponding fields existing in Zenodo.org: - *Digital Object Identifier* - *Publication date* - *Title* - *Authors and affiliations* - *Description* - *Keywords* - *Access right* - *License* - *Community* - *Grants* **Standards:** Data and metadata will be given in standard US English. Each data set will be accompanied by a description (field available on Zenodo.org) to identify contents and experimental conditions. Openly shared LEDtech-GROW data will be identified according to the following guidelines: • Data related to a published research article will be named as follows: "First author name _ Article reference_ Figure number (letter)_version.extension" in which the article's reference will be stated as: "Standard Journal Abbreviation + issue number(year)page" and the version will be abbreviated as "v" and numbered in increasing order from less to more recent, starting by 1 with increments of 1 unit, e.g. "v1, v2, v3…".

	• For figures, tables, or calculations involving or yielding an ensemble of data files, those will be shared within a compressed folder following the above-stated naming convention, in which, the 'extension' will correspond to a standard compressed folder extension (e.g. .zip). In such cases, the name of the individual files included in the compressed folder will be freely chosen by the data owner, making sure that name repetition does never occur and that the content of each file is clearly described in a supporting text file. • Data from other sources, e.g. public presentations, posters, summary reports, etc. will be shared within a single compressed folder named: "First author _ DOI Zenodo _version.compression extension" in which, the DOI given by Zenodo.org will be used to link the data to its source (e.g. conference poster).
Data Sharing	The data generated by the project will be shared among the project members whenever necessary. A shared platform on the ASANA website will be used to upload and share generated data by the project team members. Those interested in LEDtech-GROW data can access most of those data (public) mainly through publications (Open Access Scientific Journals) dissemination materials, Zenodo.org, and the VinaR repository. Raw and processed data will be openly accessible according to decisions from the project management team. LEDtech-GROW data will be available through the Zenodo.org website. This is a catch-all repository for EC-funded research provided by CERN, an OpenAIRE partner. Zenodo.org does not require an account, log in, or password to give free access to the deposited data. The Creative Commons Licensing will be used for all data deposited on Zenodo.org, protecting the ownership of each data set. LEDtech-GROW data will mostly be available for reuse as soon as possible. If the data are used in a publication or other, they will be deposited on Zenodo.org and the VinaR repository. The access to the data will follow the same embargo as the publication deposited on Zenodo.org.
Archiving and preservation (including storage and backup)	Each LEDtech-GROW team member is responsible for data quality since they are data producers. In any case, the project follows the standard practices in physics and chemistry: reproducibility, reliable statistical analysis, noise/error bars evaluation, and consistency with other experimental results and theories. Zenodo.org server will allow the long term of data generated; at least as long as CERN is operating. If for some reason Zenodo.org closes, the migration to another repository will be guaranteed.
Reported by	The data set generator

6. Allocation of Resources and Responsibilities

Compliance with FAIR principles implies costs. These can be related, for instance, to Open Access publication, project website maintenance, use of repositories, or copyright licensing. The table below lists some of the costs identified:

Publication in "Open Access journals"	Costs related to open access to research data in the PROMIS2023 Program (The Science Fund of the Republic of Serbia) are eligible for payment under the conditions defined in the Contract. In this regard, these costs were anticipated and considered in the project budget. The cost of sharing, in the case of multiple authors, will be decided among the authors on a case-by-case basis.
Project Website Operation	Supported by the project management team
ASANA web platform	Supported by the project management team
Data archived at ZENODO	Free of charge
Data archived at VinaR	Free of charge
Other fees	As the project is responsible for the data it produces, any other fee will be the responsibility of the LEDtech-GROW project.
Long-term preservation and storage	Data preservation for at least 1 year after the project ends is required. The final dataset will be transferred to the ZENODO repository, which ensures sustainable archiving of the final research data. Additional data storage will be ensured by the VinaR data repository.

The VINS, the only institution involved in the realization of the project, will be responsible for DMP writing/updating/ coordination as well as, together with the LEDtech-GROW project management team, by monitoring its implementation, ensuring that all the project members comply with it. Each project member is responsible for the data it produces (data generation, metadata production, data quality, and proper data management), and should comply with the present deliverable and included guidelines.

7. Data Security

The LEDtech-GROW approach for the sake of data security will follow the provisions listed below:

- Data should be stored in at least two different locations to avoid data lost;
- Data should be encrypted whenever necessary (e.g. confidentiality issues);
- The use of USB flash drives should be limited;
- Follow a systematic labeling procedure to ensure coherence among the datasets.

Data will be uploaded to Zenodo.org and stored in the CERN Data Centre. On the long-term storage, the institutional repository should provide a satisfactory level of security.

To date, no major issues regarding personal data security have been foreseen.

8. Ethical Aspects

All the actions, protocols, and procedures related to the LEDtech-GROW project described are not subject to any Ethics Directives and Rules delivered by the respective laws of the Republic of Serbia.

9. Other Issues

Details concerning other national/funder/sectorial/departmental procedures for data management are not herein presented as this is a public DMP release.

10.   Conclusions

The present DMP constitutes the first release of the LEDtech-GROW DMP and is planned to be updated. If necessary, an updated version of this list will be provided at the end of the project.

11.   Bibliography and Sources

[1] European Comission, "H2020 templates :Data Management Plan v1.0," 2016.

[2] European Commission , "Guidelines to the Rules on Open Access to Scientific Publications and Open Access to Research data in Horizon 2020," European Commission - Directorate For Research and Innovation , Bruxelles, 2017.

[3] European Comission, "guidelines on FAIR data management in Horizon2020," European Comission, 2016.

[4] Force11 discussion forum, "The FAIR data Principles," Force11, [Online]. Available: https://www.force11.org/group/fairgroup/fairprinciples.European Comission, "guidelines on FAIR data management in Horizon2020," European Comission, 2016.

[5] Wilkinson, M. D. et al. The FAIR Guiding Principles for scientific data management and stewardship. Sci. Data 3:160018 doi: 10.1038/sdata.2016.18 (2016).

12.   Annexes

Annex I

Expected Data File Extensions in LEDtech-GROW

File ext.	Description	Editing software
dat	Generic data file	**Text editors (e.g. Notepad)**
txt	Text file	**Text editors (e.g. Notepad)**
doc	Text file	**MS Word**
xls	Spreadsheet	**Spreadsheet software (e.g. MS Excel)**
cvs	Spreadsheet	**Spreadsheet software (e.g. MS Excel)**
jpg	Raster image	**Standard image viewers**
png	Raster image	**Standard image viewers**
tif	Raster image	**Standard image viewers**
nb	Code	**Wolfram Mathematica**
xml	Code	**XML editors**
m	Code	**Mathworks Matlab**
pdf	Portable document format	**Standard PDF viewers**
zip	Archive file format	**Standard file archivers**
rar	Archive file format	**Standard file archivers**