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HYBRID TANDEM CATALYTIC CONVERSION PROCESS TOWARDS HIGHER OXYGENATE E-FUELS

E-TANDEM - Deliverable report

Deliverable 1.3 – Final Data Management Plan

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Summary

Deliverable report D1.3 “Final Data Management Plan” is a deliverable associated with the management work package (WP1) via task 1.3 ‘Open Science Practices and data management’.

This deliverable is an update of D1.2, the “Initial Data Management Plan” of E-TANDEM, which was submitted in M8, in which partners had outlined the characteristics of the data and methods to be generated during the project, how data would be curated, stored and managed, and the necessary measures to ensure data was accessible, assessable, usable, and interoperable by the project partners. It also described relevant data security aspects.

As the end of E-TANDEM is approaching, D1.3 looks backward and reports on the consistency and effectiveness of the data management measures. In this deliverable, partners report on whether the data management measures outlined in D1.2 were adhered to in practice and, where necessary, describe alternative approaches adopted to reduce the operational burden of data management. In addition, the data summary has been updated to account for (i) experimental procedures that were not previously foreseen, (ii) changes in the software tools used, and (iii) the redistribution of work following the withdrawal of the task leader partner, Finco Energies. Finally, partners assess the current accessibility and interoperability of the data generated, with a view to its potential re-use in the near future, and provide a set of recommendations.

D1.3 is based on the template provided by the European Commission [1]. After introducing E-TANDEM (Chapter 1), Chapter 2 summarizes how FAIR compliance was achieved and key deviations, Chapter 3 presents an update on the Data Summary - what was generated (type/volume), how data was handled, where it is stored. Finally, Chapters 4 presents an update on the allocation of resources, including data security, and ethical aspects.

Contents

List of Tables

Abbreviations & Definitions

Abbreviation	Explanation
ASCII	American Standard Code for Information Interchange (standard file format)
CD	Communication & Dissemination
CSV	Comma-Separated Values (standard file format)
DMP	Data management plan
DOI	Digital Object Identifier
EC	European Commission
EU	European Union
FAIR	Findable, Accessible, Interoperable and Reusable
FID	File IDentifier
GA	General Assembly (meetings)
GDPR	General Data Protection Regulation
HTML	HyperText Markup Language (standard file format)
IP	Intellectual Property
IPR	Intellectual Property Rights
JPEG	Joint Photographic Experts Group (standard image file format)
PNG	Portable Network Graphics (standard image file format)
PDF	Portable Document Format (standard file format)
RTF	Rich Text Format (standard text-based file format)
TIFF	Tagged Image File Format (standard image file format)
TXRM	Tomographic X-ray Microscopy
XRM	X-ray Microscopy

1 Introduction

The European Commission (EC) urges on the implementation of open access to scientific publications and research data derived from the European Union (EU) funded research projects [1]. This is reflected in the standardization of procedures to achieve Findable, Accessible, Interoperable and Reusable (FAIR) research data. The main objective behind this EC action is to maximise the impact of EU funded research projects and accelerate findings through the interaction of the data produced in different research projects. This document provides an update to the Data Management Plan (DMP) for the E-TANDEM project. Specifically, the deliverable evaluates how research data was handled during the project and provides adjustments and/or recommendations for handling after the end of the project and for future DMPs, gives updates on what data was generated, processed and collected, what and how was data made publicly available, and how data will be curated and preserved after the end of the project.

This project has used a standard methodology already developed in the GREENCAP project (Grant Agreement number 101091572), following EU recommendations. Ad hoc modifications were added to comply with the Grant Agreement conditions for E-TANDEM (Grant Agreement number 101083700).

1.1 E-TANDEM summary

E-TANDEM developed and validated, at bench scale, the first direct process for the selective production of carbon-neutral higher oxygenate e-fuels (HOEF) from CO_2, water, and renewable power. The HOEF is composed of, in a first realization, a mixture of higher aliphatic alcohols with more than four carbon atoms (C_{5+}); and in a second realization, a mixture of symmetric and asymmetric higher (C_{8+}) aliphatic ether derivatives of said higher alcohols. The HOEF is liquid at ambient conditions and expected to unite high cetane index with mild oxygenate character. These features shall contribute to solve limitations associated with state-of-the-art hydrocarbon and heavily oxygenated (methanol, DME) e-fuels, showing advantageous logistics, superior combustion, and favourable tailpipe emission reduction properties for the heavy-duty marine and road transport sectors. The e-fuel production concept integrates a first CO_2/H_2O high-temperature co-electrolysis step with the downstream thermocatalytic conversion of the resulting e-syngas (H_2+CO) stream into higher oxygenates in a slurry-phase tandem Fischer-Tropsch/reductive olefin hydroformylation/alcohol dehydration process. Moreover, the project has benchmarked the new HOEF and blends thereof against relevant heavy-duty and marine diesel fossil fuels and carried out process techno-economic and life-cycle analyses to assess the soundness of current fleet-compatibility, sustainability, and societal aspects of the newly proposed e-fuel and its production concept.

1.1.1 Document structure

This document first summarizes the planned procedures to implement FAIR compliance and key deviations. Chapter 3 presents an update on the Data Summary:

(i) what was generated (type/volume),
(ii) how data was handled, and
(iii) where it is stored.

Chapters 4 presents an update on the allocation of resources used to implement FAIR principles and data management, including data security and ethical aspects. In Chapter 5 Conclusions and Recommendations are given. The last chapters 6-8 are of administrative nature, such as Risks and interconnections, Deviations from Annex 1, and the necessary references to complete the DMP.

2 FAIR Data and E-TANDEM

During the course of the E-TANDEM project, the FAIR data principles [2] have been applied in practice in line with European Commission guidelines and the principle of making data "as open as possible, as closed as necessary" [3]. The focus of data management activities progressively shifted from planning to implementation, with partners adopting concrete measures to ensure that research data generated across work packages were findable, accessible, interoperable, and reusable, while respecting confidentiality, intellectual property, and legal constraints.

Core of the E-TANDEM approach has been:

Making data findable: Research data and public deliverables generated during the project were made findable through the systematic use of descriptive metadata and, where applicable, persistent identifiers, such as Digital Object Identifiers (DOIs). Metadata elements based on the Dublin Core Metadata Element Set were applied in repositories and internal platforms, enabling identification, validation, and retrieval of datasets and documentation linked to scientific outputs.

Naming the data and files: A consistent naming and versioning convention (E-TANDEM-DATA_TYPE-DATE.EXTENSION) was applied across datasets and project documents, allowing unambiguous identification of data type, creation date, dissemination level, and document status. Version control practices were followed throughout the project, clearly distinguishing draft versions from final submissions to the European Commission and supporting traceability of updates over time.

Making data openly accessible: Public deliverables and selected datasets have been made openly available through appropriate channels, including the CORDIS portal of the European Commission (which effectively acts as a repository) and the E-TANDEM project website, without access restrictions. Their availability has also been communicated to a broad audience via the project's biannual newsletter. Data classified as consortium-level or confidential have been stored in secure internal platforms (METT, transitioned to an equivalent MS Teams® platform in January 2025, and partners' institutional servers) with restricted access, and, where appropriate, shared externally only under agreed conditions (e.g. non-disclosure agreements), in line with the project's IPR framework.

Making data interoperable: Interoperability was ensured by using standard, widely adopted file formats and commonly available software tools wherever possible, while specialist software required for modelling or physico-chemical analyses was made accessible to partners as needed. When feasible, data were exported to standard formats to facilitate exchange and reuse beyond the original software environment.

Increase data re-use (through clarifying licenses): Data reuse considerations were addressed on a case-by-case basis, taking into account the nature of the data, confidentiality constraints, and potential commercial value. Where possible, permissive reuse conditions were favored in line with Horizon Europe recommendations, while more restrictive arrangements were applied to sensitive data; non-confidential datasets were considered suitable for reuse for a limited period following project completion.

2.1 Differences with respect to D1.2

1. Towards the end of the project (January 2025) the main consortium-level repository was transferred from METT to Microsoft Teams®, both hosted by UNR.

3 Data Summary

Within E-TANDEM, two types of data have been identified: personal data and research data. E-TANDEM has collected **personal data** (name, email, organization, LinkedIn ID) mainly for communication and dissemination purposes (e.g. diffusion of newsletters, LinkedIn posts, registration to workshops and online meetings, publicity around E-TANDEM results and activities). As CD manager, UNR complied with the General Data Protection Regulation (GDPR) and procedures for personal data processing, as set out in the EU Regulation EU/2016/679.

With regards to **research data**, Table 3-1 reports the list of data type and formats updated at the end of the project.

Table 3.1 Standard formats for collection, storage and curation of raw research data, worked-out data and data included into reports, within E-TANDEM.

Data type/level	Typical data format
Raw research data	
Chromatograms, spectra, electrochemistry testing results, etc	ASCII, CSV, TXT, FID
Electron micrographs (SEM, FIB-SEM, TEM)	JPEG, TIFF, PNG
X-ray tomograms	XRM, TXRM
Scripts	HTML, RTF, MLX
Worked-out data	
Numerical, tabulated data	(Excel sheets) XLSX, Origin projects (OPJ)
1D and 2D chromatograms	JPEG, TIFF, PNG, EPS
ASPEN/HYSYS chemical process models & simulations; openLCA, R&D GREET2025; Mass & energy balances (all inputs and outputs included) – (Excel) Economic modelling	APW, HSC, XLSX exported
Flame imaging as part of Soot Yield Index determinations: combination of image (photographic) and text data	CR2 (e.g. Canon cameras), DOCX, PPT
Process flow diagram and relevant info (chemical, T, P, requirements) – economic modelling and LCA	PPT, Excel
As part of reports/analyses	
Project internal communications, official project reports, literature review	DOCX, PDF, PPT

The data collected by the implementation E-TANDEM consortium has been shared, on request and under Non-Disclosure Agreement (NDA), with delegates from the project's Stakeholders Board. The formats applied for such data sharing are PDF and PPT.

3.1 Additions and/or differences with respect to D1.2

A new file format has been introduced for the lossless, high-resolution storage of images acquired during flame imaging for soot yield measurements (WP3, OWI).

Life Cycle Assessment (LCA) calculations were performed using openLCA and GREET 2025 instead of GaBi, with outputs generated in XLSX format (WP5, UZ).

Following the termination of beneficiary Finco Energies (FE), Task 5.1 (TEA) was reassigned to CSIC, while maintaining the same level of openness for Deliverable 5.5.

4 Resource allocation for FAIR data and data security

During the project, resource allocation, data security measures, and governance structures were implemented to support the practical application of the FAIR data principles described in Chapter 2, while ensuring compliance with confidentiality, intellectual property, and ethical requirements. Roles and responsibilities were clearly defined, and existing institutional and project-level frameworks were used to ensure sustainable data handling during and after the project.

4.1 Additions and/or differences with respect to D1.2

Allocation of resources: No major deviations from the planned allocation of resources were identified. Roles and responsibilities for data management remained aligned with the Description of Action. Following the termination of beneficiary Finco Energies (FE), the relevant tasks were reassigned within the consortium, as reflected in the corresponding amendment to the Grant Agreement, without affecting data management procedures or responsibilities. Quality assurance of data was ensured by each partner according to established internal protocols and agreed consortium practices.

IPR Protection Strategy: The partners have signed a CA at the kick-off of the project, short after the signature of the Grant Agreement with the EC, in which all the rules ensuring confidentiality (procedure for granting publication of the results), ownership regime, and IPR issues (background included and excluded, ownership, licensing terms, etc.) are detailed. Background and foreground IP ownership and access rights were respected, supporting responsible data reuse and exploitation, with decisions on publication and licensing taken at consortium level on a case-by-case basis in line with the intended impact and sensitivity of the results.

Data security: Each partner ensured secure storage, backup, and recovery of their data according to institutional policies, while public deliverables and shared project documentation have been centrally managed via the METT platform (replaced by a Microsoft Teams® platform in January 2025) to guarantee availability, continuity, and controlled access.

Other ethics and issues: No ethical issues affecting FAIR data sharing were identified during the project, and data handling practices remained compliant with EC policies and the Consortium Agreement.

5 Conclusion and recommendations

The implementation of the Data Management Plan (DMP) in E-TANDEM has been overall effective and aligned with Horizon Europe requirements. The consortium successfully transitioned from planning to execution of FAIR data practices, ensuring that research outputs were, where possible, findable, accessible, interoperable, and reusable, while respecting confidentiality, intellectual property, and ethical constraints.

Data management procedures proved robust and adaptable to project developments, including the introduction of new experimental methods, changes in software tools, and the reallocation of tasks following the termination of a project partner. The use of standard file formats, structured naming conventions, and centralized collaboration platforms facilitated efficient data handling, sharing, and traceability across partners.

Public deliverables and selected datasets were successfully disseminated through appropriate channels, while sensitive data were adequately protected through controlled access mechanisms and IPR frameworks, and shared, upon request and under NDA, with delegates from the project's Stakeholder Board members. No issues related to data security, ethics, or compliance with GDPR were identified.

6 Risks and interconnections

No risks arisen related to this deliverable.

6.1 Interconnections with other deliverables

This Data Management Plan (DMP) is closely linked to the technical and assessment deliverables generated across the project, as it identifies the types of data produced, their origin, and the partners responsible for their generation and handling. In this context, the DMP supports traceability between datasets and the results reported in other deliverables.

Furthermore, by clarifying data ownership, access rights, and handling procedures, the DMP provides a foundation for the identification and protection of results with potential for exploitation. It therefore contributes to the project's overall strategy on intellectual property management, ensuring that data underpinning exploitable results is properly documented, managed, and, where appropriate, protected.

7 Deviations from Annex 1

There are no deviations from the description of this deliverable as given in Annex I of the Grant Agreement.

8 References

[1] European Commission (2016) Guidelines on FAIR Data Management in Horizon 2020. Online available:https://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/oa_pilot/h2020-hi-oa-data-mgt_en.pdf

[2] M. D. Wilkinson et al., "The FAIR Guiding Principles for scientific data management and stewardship," Sci. Data, vol. 3, no. 1, p. 160018, Dec. 2016, doi: 10.1038/sdata.2016.18.

[3] European Research Council (ERC), "Guidelines on Implementation of Open Access to Scientific Publications and Research Data in projects supported by the European Research Council under Horizon 2020," no. April, pp. 1–7, 2017.

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Project partners:

#	Partner short name	Partner Full Name
1	CSIC	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS
2	MPG	MAX-PLANCK-GESELLSCHAFT ZUR FORDERUNG DER WISSENSCHAFTEN EV
3	DTU	DANMARKS TEKNISKE UNIVERSITET
4	OWI	OWI SCIENCE FOR FUELS GMBH
5	UNR	UNIRESEARCH BV
6	T4F	TEC4FUELS GmbH
7	AVL	AVL LIST GMBH
8	UZ	SVEUCILISTE U ZAGREBU, FAKULTET STROJARSTVA I BRODOGRADNJE
9	UCT	UNIVERSITY OF CAPE TOWN
10	KAUST	KING ABDULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

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