

HORIZON EUROPE PROGRAMME  
TOPIC HORIZON-CL5-2021-D3-03-03

GA No. 101083700

HYBRID TANDEM CATALYTIC CONVERSION PROCESS  
TOWARDS HIGHER OXYGENATE EFUELS



**E-TANDEM - Deliverable report**

**D4.3 - Modelling & simulation of higher oxygenate e-fuel  
production route**



**Funded by  
the European Union**



<b>Deliverable No.</b>	E-TANDEM D4.3	
<b>Related WP</b>	WP4.3	
<b>Deliverable Title</b>	Process modelling: efficiency analysis	
<b>Deliverable Date</b>	2026-02-28	
<b>Deliverable Type</b>	REPORT	
<b>Dissemination level</b>	Sensitive – member only (SEN)	
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<b>Status</b>	V1.0	2026-03-03

#### Document History

Version	Date	Editing done by	Remarks
V01	2026-02-23	Markus Goll	Sent to internal review
V02	2026-02-23	Vincent Lawlor	Approved internally
V03	2026-02-27	Szabolcs Tot & Markus Goll	Updated as suggested by MPG
V1.0	2026-03-03	Markus Goll	Updated as suggested by project coordinator

#### Project summary

E-TANDEM’s ambition is to unlock an efficient and direct production of a new higher-oxygenate diesel-like e-fuel for the marine and heavy-duty transport sectors. This oxygenated fuel is directly produced from water, CO<sub>2</sub>, as the sole carbon source, and renewable power as the sole energy input, in a one-through hybrid catalytic conversion process integrating three major catalysis branches: (1) high-pressure electrocatalysis syngas production coupled to a tandem catalytic e-syngas conversion, encompassing (2) thermocatalysis with solid catalysts and (3) chemocatalysis with molecular complexes. The project will demonstrate the new e-fuel production process at bench-scale, and assess its industrial scalability.

#### Disclaimer

This report was prepared with the assistance of artificial intelligence tools, which supported the formulation and refinement of the written content. All technical information originates from the author, and no technical content was modified by these tools.



## Publishable summary

The E-TANDEM project develops an integrated process for producing higher-oxygenate e-fuels from CO<sub>2</sub>, water, and renewable electricity. These fuels are intended for applications such as marine and heavy-duty transport, where low-carbon alternatives are limited. The process combines high-pressure co-electrolysis (Co-SOEC) for e-syngas generation with a tandem catalytic conversion to higher alcohols, followed by product purification and dehydration of alcohols to produce higher ethers. Bringing these elements together into one coherent process chain is essential for evaluating the technical and economic potential of the concept.

This report provides a complete process description that unifies the results from several work packages into a consistent overall model. Data from the development of the Co-SOEC unit, the tandem catalytic reactor, and the catalyst-recycle system form the basis for describing the core conversion steps. These are complemented by the process steps required to isolate the fuel components and convert the alcohol fraction into the corresponding ethers. The resulting process flow design illustrates how the individual units function when combined into a single, consistent process chain.

A reference scale of 1 MW direct electrical input to the electrolysis unit was selected. This scale provides a practical basis for calculating mass and energy flows, ensures comparability across the project, and supports the techno-economic and environmental assessments carried out in WP5. It represents a meaningful early-stage size for evaluating the performance and feasibility of the overall process.

Process simulation plays a central role in developing the integrated process flow. It allows data from different subsystems to be combined under consistent assumptions and enables the analysis of interactions between units. Simulation helps identify major energy demands, assess the influence of design choices, evaluate overall system performance, and generate the quantitative data required for further processing steps such as techno-economic and environmental assessments. This approach ensures that the process model is coherent and ready for use in the subsequent evaluation tasks.

The resulting process description comprises the full process flow diagram, the key modelling assumptions, and the mass- and energy-balance calculations for the 1 MW reference case. Together, these elements provide the technical basis for the assessments in WP5 and support the project's broader goal of demonstrating a viable pathway for producing higher-oxygenate e-fuels from renewable resources.



## 7 Acknowledgement

The author(s) would like to thank the partners in the project for their valuable comments on previous drafts and for performing the review.

### 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
9	UZ	SVEUCILISTE U ZAGREBU, FAKULTET STROJARSTVA I BRODOGRADNJE
10	UCT	UNIVERSITY OF CAPE TOWN
11	KAUST	KING ABDULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

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This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101083700. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.