SOMMER

Solar-Based Membrane Reactor for Syngas Production

D1.2 Quality Management Plan

WP1 – Project Management, Coordination & Dissemination

31.01.2024

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Disclaimer

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Acknowledgement

The project SOMMER is funded by the European Union under Grant Agreement Number 101118293.

Document Identifier

Grant Agreement No.	**101118293**		**Acronym**	**SOMMER**
Title	Solar-based membrane reactor for syngas production			
Call Topic	HORIZON-CL5-2022-D3-02-06			
Type of action	HORIZON EUROPE, RIA - Research and Innovation Actions			
Start date	01.11.2023		**Duration**	48 months
Project URL	N/A			
Project Officer	Dr. Luca Bondi			
Project Coordinator	DLR - German Aerospace Center			
Deliverable	D1.2 Quality Management Plan			
Date of Delivery	**Contractual**	31.01.2024	**Actual**	31.01.2024
Nature	Report	**Dissemination level**		Public
Lead Beneficiary	DLR - German Aerospace Center			
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Final version approval date	31.01.2024			

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About the Project

SOMMER aims to develop and demonstrate an innovative carbon-neutral process for syngas production by directly integrating solar energy into a catalytic membrane reactor, facilitating the decomposition of H_2O and CO_2 (e.g., captured from carbon-emitting industries or through direct air capture). This approach enables SOMMER to overcome reliance on fossil-based energy for syngas production, utilizing CO_2 instead of natural gas as a feedstock. Syngas, a critical intermediate for the chemical industry, prompts SOMMER to encompass the entire value chain - from CO_2 provision in a cement plant to syngas formation and further processing into valuable products like DME or methanol. The core of SOMMER's technology is the optimized energy integration of a novel thermochemical conversion process of CO_2 and H_2O in a single step. This process is supported by highly selective catalysts, a dual-phase composite membrane, and a concentrated solar-thermal plant fulfilling the thermal energy demand. The key outcomes of SOMMER involve the experimental demonstration and evaluation of the innovative solar-powered membrane technology. Additionally, it focuses on developing high-performance, cost-effective membranes as pivotal components, elevating the technology to new heights. SOMMER's strategy involves advancing membrane manufacturing through slip-casting, a more mature approach, and additive manufacturing to optimize the effective membrane surface area in the reactor. The concept anticipates future advantages, allowing prolonged and flexible operation by seamlessly switching between two operational cases: I) Purely solar approach at 1500 °C and II) a biogas-supported approach at 900 °C. Furthermore, SOMMER aims to identify the technological, ecological, and economical potential for flexible and highly efficient solar syngas production, contributing to the formulation of a detailed roadmap and providing a foundation for pre-commercialization through subsequent R&D development activities.

DLR	Deutsches Zentrum Für Luft - und Raumfahrt e.V.	DE	
FZJ	Forschungszentrum Jülich GmbH	DE	
IREC	Fundacio Institut De Recerca De L'Energia De Catalunya	ES	
HTE	HTE GmbH The High Throughput Experimentation Company	DE	
CSIC	Agencia Estatal Consejo Superior De Investigaciones Científicas	ES	
MAM HW	Morgan Advanced Materials Haldenwanger GmbH	DE	
TITAN	TITAN Cement Company S.A.	GR	
BASF*	BASF SE	DE	

*Associated Partner

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Document Summary

This document serves as Deliverable D1.2, the 'Quality Management Plan,' developed within WP1 of the HORIZON EUROPE SOMMER project. It outlines essential quality planning provisions and guidelines for adoption by the partners, ensuring the smooth implementation of the SOMMER project and timely submission of high-quality deliverables to the EC services. A comprehensive quality procedure has been established for project deliverables and reports. Each project deliverable undergoes quality review by at least one internal reviewer (a member of the consortium) and by the Project Coordinator before submission to the EU's funding agency. This procedure aims to ensure that submitted deliverables meet quality criteria, including clarity, completeness, accuracy, relevance, and technical compliance. Relevant quality assurance procedures will also be implemented for project reports and dissemination materials. Additionally, a risk management plan is in place, identifying both technical (research-oriented) and management (project implementation-related) risks, along with mitigation actions for each case.

Changes with Respect to the DoA

The risk assessment regarding likelihood before and after mitigation methods was reassessed and two risks were adapted in comparison to the DoA

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1. Introduction

Deliverable 1.2, the Quality Management Plan (QMP), is generated as part of the Project Management, Coordination, and Dissemination work package (WP1). Its primary objective is to delineate the approach to be employed throughout the project, ensuring the timely completion of tasks and maintaining a high standard of performance and quality in project outcomes. This document is crafted based on the Description of Work (DoW) outlined in the proposal, incorporating any modifications made during the Grant Agreement preparation process. Additionally, it draws from discussions held during the project kick-off meeting on November 23–24, 2023. The QMP works in tandem with Deliverable 1.1, the Project Management Plan (PMP), where the project management bodies, their roles, responsibilities, internal communication plan, deliverables, and work breakdown schedule are comprehensively outlined.

In this context, the specific objectives of this deliverable are to:

- establish the processes for ensuring the quality of the project deliverables and reports,
- analyse the potential risks of the project that may jeopardise quality and evaluate their impact;
- proactively define planned risk mitigation measures to guarantee proper execution of the project's tasks.

In order to ensure its relevance throughout the lifetime of the project, the QMP will be revisited regularly and updated when deemed necessary.

2. Quality Assurance of Project Reports

As described in D1.1, the project is divided into three reporting periods (RPs):

- RP1: from Month 1 to Month 18 (i.e. November 1, 2023 – April 30, 2025).
- RP2: from Month 19 to Month 30 (i.e. May 1, 2025 – April 30, 2026).
- RP3: from Month 31 to Month 48 (i.e. May 1, 2026 – October 30, 2027).

Within 60 days from the end of each RP, a Report must be submitted to the granting authority by the PC, i.e. two **Periodic Reports and a Final Report** are due in total; they are mandatory and linked to interim and final payments by the granting authority.

The periodic and the final reports contain

a) a "periodic technical report",
b) a "periodic financial report".

The requirements and contents for each are outlined in the Grant Agreement. It is crucial to emphasize that while the Project Coordinator (PC) is accountable for uploading the "periodic technical report," the responsibility for the "periodic financial report" and the relevant cost statements of the partners lies solely with each beneficiary.

The continuous reporting module on the EC participant portal was activated at the project's commencement date and remains consistently accessible for submitting deliverables and reporting milestones. After the conclusion of each reporting period, the functionality for periodic reporting in the Participant Portal becomes active. This enables each participant to complete their own Financial

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Statement online, and allows the Project Coordinator to upload the corresponding technical report for the period. The final versions of Periodic Reports are uploaded and stored in the Data Repository. The process and timeline for preparation and review, ensuring the reports' high quality, involve the steps delineated in Table 1

Table 1: Process for the delivery of project's official periodic reports.

When	Who	What	Recipient
1 day after the end of the reporting period	Project Coordinator	Asks the task leaders to provide all relevant technical data, information and input to the respective WP leaders within two weeks.	Task Leaders (and all partners).
15 days after the end of the reporting period	Task Leaders	WP leaders have all necessary technical data, information and input from their WP tasks.	WP leaders
25 days after the end of the reporting period	WP leaders	WP leaders consolidate their WP tasks data, articulate their WP report into the relevant periodic report template and send it to the PC. PC asks all partners to start preparing the financial report.	Project Coordinator
40 days after the end of the reporting period	Project Coordinator	PC synthesizes draft periodic report from relevant WP leaders' data and sends it to the partners for reviewing.	All partners
45 days after the end of the reporting period	All partners	Reviewers (all partners) send comments to the PC as a Track Changed document. The Reviewers are responsible for performing Quality Assurance whereby the document will be assessed according to specific quality criteria.	Project Coordinator
50 days after the end of the reporting period	Project Coordinator	The PC sends the revised document to all partners for final review. If in the case the document fails to match the QA criteria, the GA will be notified and will set out steps to be taken to improve the report's quality.	All partners, General Assembly (GA)
40-55 days after the end of the reporting period	All partners	Provide their own financial statements and upload it in the participants portal	EC
55-59 days after the end of the reporting period	All partners Project Coordinator	Reviewers confirm document is accepted. PC puts together the Final version of Part B of the report and submits it to the participant portal.	EC

3. Quality Assurance of Project Deliverables

As part of the Quality Management Plan, the consortium will implement an internal reviewing procedure to uphold the quality of its results. Each Work Package (WP) leader will assume responsibility for the quality of results within their respective WP, and each partner accountable for a

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deliverable must ensure the quality of the presented results, especially within that specific deliverable, subject to peer review by another member of the project team. Before submission, each project deliverable will undergo a quality review by at least one internal reviewer, a member of the consortium partners.

In general, the Project Coordinator (PC) will invite all consortium partners to express their interest in reviewing upcoming deliverables for the next six months. The allocation of reviewers will then be based on declared interest, partners' technical expertise, and overall availability. However, the overarching principle is to assign a reviewer who is not involved with the specific WP associated with the deliverable, if possible. This ensures a quasi-third-party assessment and critique. Conversely, the reviewer should possess relevant technical expertise in the topic under review. Therefore, in cases where identifying an external reviewer outside the Deliverable's WP is not feasible (e.g., in Deliverables or WPs with widespread partner participation), the Deliverable draft will be circulated to all parties.

With the aforementioned rationale, a tentative list for the allocation of reviewers per Deliverable, as per Table 2, has been compiled. Naturally, the list may be subject to change during the project, depending on partner involvement, technical expertise, availability, etc. Regardless, these steps should be initiated at least 10 days before the deliverable submission deadline to ensure timely submission.

The quality of the deliverables will be evaluated against specific quality criteria to maintain uniformity and consistency in the review process for all deliverables and to ensure that reviewers clearly understand and comply with the process. Given that most deliverables are public, both primary authors and reviewers (evaluating criteria) should pay attention to the following points:

- The language of the text is clear, unambiguous and useful to the targeted audience (e.g. scientists, policymakers, etc.) and there are no spelling errors.
- The terminology, including acronyms is explained.
- Any potentially sensitive information is appropriately worded to safeguard the interest of the involved consortium partners.
- Credit to all prior work cited is acknowledged with respective references.
- The content is relevant to the scope of the deliverable and all aspects of the deliverable as described in GA-A1 (Description of the Action) are fully addressed.

In case where the EC would request a revision of a submitted Deliverable, the internal review process will be repeated.

Table 2: First tentative allocation of internal reviewers to project deliverables.

No	Deliverable Name	Responsible partner	Responsible Reviewer
D1.1	**Project Management Plan with Gantt chart and Work Breakdown Structure**	DLR	All
D1.2	**Quality Management Plan**	DLR	All
D1.3	**Launch of project's website, protected acronym, electronic communications network and social media account.**	DLR	All
D1.4	**Data Management Plan**	DLR	All
D1.5	**Dissemination and exploitation plan**	DLR	All

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D1.6	**First version of revised project management plan**	DLR	All
D1.7	**Dissemination and exploitation plan updates**	DLR	All
D1.8	**Second version of revised project management plan**	DLR	All
D1.9	**Workshop on project's final achievements & future collaboration perspectives**	DLR	All
D1.10	**Virtual Reality tool for dissemination of project results**	DLR	All
D2.1	**Identification of suitable material system for membranes and catalysts**	CSIC	DLR
D2.2	**Membrane manufacturing per slip-casting in lab-scale size using the most promising identified material candidates established**	FZJ	hte
D2.3	**Membrane manufacturing per 3D-printing in lab-scale size using the most promising identified material candidates established**	IREC	MAM HW
D2.4	**Oxygen permeability data of (first generation) membrane samples ready**	CSIC	FZJ
D2.5	**Definition of multi-layer catalytic membrane material and microstructure for scaled-up membrane units for operation in the solar membrane reactor**	MAM HW	DLR
D2.6	**Kinetics measurement data of most promising catalytic membrane assemblies collected**	hte	FZJ
D2.7	**Report on mechanical stability of slip-casted and 3D-printed membranes samples at high temperature**	FZJ	DLR
D2.8	**Report on degradation of used membrane units in solar membrane reactor**	FZJ	MAM HW
D3.1	**Definition of operational parameters of solar membrane reactor operation (pressure and temperature range), as well as gas compositions.**	DLR	FZJ
D3.2	**Selection of most advantageous approach for pO2 reduction for Case I operation**	DLR	CSIC
D3.3	**Definition of downstream process parameters**	hte	IREC
D3.4	**Calculate cost range of end product methanol / DME**	hte	Titan
D3.5	**Assess environmental impact of syngas and end product**	DLR	BASF
D4.1	**Model of solar membrane module completed and verified**	CSIC	IREC
D4.2	**Design of solar interface completed**	DLR	CSIC
D5.1	**Model of solar membrane reactor design finalized**	DLR	FZJ
D5.2	**Solar flux guide tested**	DLR	hte
D6.1	**Design parameters for CO2-providing process (cement plant) defined for process simulation**	TITAN	hte
D6.2	**Roadmap for integration of SOMMER technologies in the cement industry**	TITAN	DLR
D6.3	**Roadmap with theoretical efficiencies of ideal membrane reactor; and benchmark of our system**	FZJ	CSIC

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4. Quality Assurance of Dissemination Materials

The additional scientific and policy-related outputs of the project, such as project commentaries, newsletters, briefs, and working documents, will undergo a review process before publication, primarily to ensure adherence to the respective templates. Since there are no specific deadlines or formal submission requirements for these materials, the procedure entails the dissemination leader, such as the corresponding author of a publication, delivering the draft document based on the authors' inputs. Subsequently, the Project Coordinator conducts a technical check.

Templates will also be devised for other communication-related project materials, like newsletters and press releases. For such resources, the Project Coordinator and their communication team will scrutinize each produced resource for completeness and assess its format for compliance with the relevant template.

The quality assessment of these materials will align with the performance indicators outlined in Annex I (Part B) of the Grant Agreement, reflecting expected policy, societal, and research/scientific impacts as listed in Table 3.

Table 3: Dissemination and Communication Targets of SOMMER.

<table>
<tr><th colspan="4">1. Dissemination and Communication Target</th></tr>
<tr><td colspan="2">Activity/Deliverable</td><td colspan="2">Target/KPIs</td></tr>
<tr><td colspan="2">Open Access Publications in scientific journals</td><td colspan="2">At least 15</td></tr>
<tr><td colspan="2">Presentations at international conferences</td><td colspan="2">At least 15 presentations</td></tr>
<tr><td rowspan="3">Solar Energy</td><td>Journals</td><td colspan="2">Solar Energy; Applied Energy; Journal of Solar Energy Engineering; Solar Energy Materials & Solar Cells, Renewable and Sustainable Energy Reviews; Energy and Environmental Science, Joule, Nature Energy</td></tr>
<tr><td>Conferences</td><td colspan="2">SolarPaces (Solar Power and Chemical Energy Systems); IRES (International Renewable Energy Storage) Conference</td></tr>
<tr><td>Partners</td><td colspan="2">DLR, CSIC</td></tr>
<tr><td rowspan="3">Materials Science and Engineering (Ceramics)</td><td>Journals</td><td colspan="2">Advanced Energy Materials, Journal of European/American Ceramic Society; Nature Materials, Journal of Materials Chemistry A</td></tr>
<tr><td>Conferences</td><td colspan="2">European Ceramics Society (ECerS) Conference; Materials Research Society (MRS) Conference; Pacific Rim Conference on Ceramic and Glass Technology, Solid State Ionics Conference</td></tr>
<tr><td>Partners</td><td colspan="2">DLR, IREC-CERCA, HTE, CSIC, HW, FZJ</td></tr>
<tr><td rowspan="3">Chemical/ Thermal/Mechanical Engineering</td><td>Journals</td><td colspan="2">Chemical Engineering Science; Applied Catalysis A/B; AIChE Journal; Industrial & Engineering Chemistry Research; Applied Thermal Engineering</td></tr>
<tr><td>Conferences</td><td colspan="2">AIChE (American Institute of Chemical Engineers) and ASME (American Society of Mechanical Engineers) Conferences</td></tr>
<tr><td>Partners</td><td colspan="2">DLR, FZJ, IREC-CERCA, HTE, CSIC, HW, BASF</td></tr>
<tr><td colspan="2">Project Website</td><td>Number of visits
Downloads of public deliverables</td><td>≥ 3000
≥ 200</td></tr>
</table>

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Flyers distributed at conferences, workshop	≥ 1000
Newsletters	6 newsletters (1 every 8 months)
Workshop	1 with **at least 50 participants**
Twitters/Facebook	At least 200 followers by the end of project
LinkedIn	Creation of account, at least 70 followers by end of project
Videos	At least 1

5. Risk Analysis

Considering the above time frame and list of milestones, the consortium has already analysed and identified the risks and conceived respective mitigation actions as summarized in Table 4 below. It is essential to note that the ongoing assessment of these risks and decisions on mitigation measures will be continuous throughout the project. As previously highlighted, challenges and associated risks can be broadly categorized into those related to materials development and those pertinent to the device level and its operation.

Table 4: SOMMER Risk analysis and relevant mitigation actions.

Description of risk	WP(s) involved	Likelihood	Severity	Proposed risk-mitigation measures	Likelihood after mitigation
Insufficient gas-tightness of the membranes	WP2, WP5	Medium	High	Usage of dense tubes with wall-thickness < 0.5 mm	Low-to-Medium
Computational requirements are too demanding for CFD modelling.	WP4	Low	Low	Use alternative model simplification strategies, e.g., numerical/fitted relationships based on given ranges of environmental conditions. Access/Acquisition of more powerful computational resources.	Low
Not possible to print the simulated & designed membrane geometries (mechanical strength too low or light scattering too high during printing).	WP2	Medium	High	Reformulate the slurry by using specific additive to limit scattering.	Low

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Materials of 3D printed membrane degrade fast over time or are not thermomechanically stable enough for the pursued application.	WP2, WP4	Medium	High	Optimization of the proposed geometries and iteration of materials selection for the different temperature ranges.	Low-to-Medium
Insufficient time for detailed experimental validation of the solar membrane reactor in test platform due to delays in components/ procurement/manufacturing	WP5	Low	Medium	A sufficient duration of 14 months is scheduled for the relevant WP5 campaign, with a buffer of 4 month before project end. Even if delays cause reduction of testing time to 9 months, this is still sufficient for reliable experimental validation.	Low
Breakage of membrane units during operation in the solar membrane reactor due to the demanding conditions	WP2, WP5	Medium-to-high	Medium	At least 4 different slip-casted membranes and 3D printed membrane will be manufactured for the implementation in the solar membrane reactor plus a buffer during manufacturing (2 – 3 times). In addition, the sufficient testing time in WP5 allows to replace broken membrane units.	Medium
Cost targets of integrated system (Methanol/ DME production) not fully met	WP3	Medium-to-high	Medium	A preliminary economic analysis and the early identification of optimal operation conditions of the membrane and downstream process in WP3, together with a feedback loop to WP2 regarding material selection will highlight in the project's beginning if material choices and component design need to be re-evaluated	Medium
Project Management Risks					

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Delays due to partner poor performance and partner dropping out of project	ALL	Low-to-medium	High	A progress monitoring will be conducted every 6 months to avoid serious delays due to poor performance, so that potential issues can be identified as early as possible. The consortium agreement will define the procedure in case a partner fails or withdraws.	Low-to-medium

6. Conclusion

Following the project kick-off meeting, a Quality Management Plan (QMP) for the project has been drafted, in close conjunction with the Project Management Plan (PMP). The QMP describes the approaches to be adopted by the partners in order to ensure that the project is implemented smoothly and all its deliverables are of high quality and submitted to the EC on time.

Basically, the approach involves timely internal reviewing of the project’s deliverables and reports by at least one internal reviewer as well as by the suitable project’s management bodies before being submitted to EU’s funding agency.

This work breakdown structure and the global timeline of the project allow to identify some initial risk issues in its course which is particularly important at this early stage in order to consider and prepare mitigation strategies and fall-back options to ensure timely completion of all deliverable and milestones. Hence, a risk management plan is put into place, consisting of the identification of the technical (research-oriented) and management (project implementation-related) risks and the mitigation actions to be employed.

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