# SOMMER

**Solar-Based Membrane Reactor for Syngas Production**

# D1.1. Project Management Plan with Gantt Chart & Work Breakdown Structure

WP1 – Project Management, Coordination & Dissemination

31.01.2024

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# Disclaimer



# Acknowledgement

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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

The present document, Deliverable D1.1, titled "Project Management Plan with Gantt chart and Work Breakdown Structure," serves as a comprehensive administrative guide for EU SOMMER projects. Developed within WP1, this document outlines the overall guidelines and procedures, providing essential insights into project structures, decision-making bodies, work plans, and the adopted management approaches. This deliverable acts as the primary source for administration-related issues within the project, offering a centralized reference for project progress and requirements. It details the channels of internal communication, encompassing physical meetings, teleconferences, an internal TeamSite for document repository and management, and structured email communication. The document includes a Gantt chart and a work breakdown structure for the SOMMER project, offering a schedule for each task, responsible partners, related subtasks, deliverables, and dependencies on other tasks.

# Changes with Respect to the DoA

The duration of WP5 has been adjusted to 44 months to align with the Gantt chart. This was a typo error in the GA.



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# Table of Contents





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# 1. Introduction

This deliverable outlines the initial project planning, the Description of Work (DoW) as proposed, and any modifications made during the Grant Agreement preparation procedure. It also incorporates insights from the project kick-off meeting held on November 23rd and 24th, 2023. Under the Management and Coordination work package (WP1), Deliverable 1.1 aims to provide a comprehensive framework for the project's structure, work plan, and management approach. It focuses on ensuring timely task completion, appropriate resource allocation, and achieving high-performance/quality results to support the partnership's scientific and technical objectives. The Project Management Plan (PMP) plays a central role in detailing how project aspects are managed, monitored, and controlled, emphasizing efficient decision-making and adaptability. Deliverable 1.1 also serves as a central reference for reporting protocols, functioning as a manual for Consortium members' day-to-day activities, establishing standardized operating procedures and methods for document provision, ensuring efficient project implementation

# 2. Consortium

This deliverable outlines the initial project planning, the Description of Work (DoW) as proposed, and any modifications made during the Grant Agreement preparation procedure. It also incorporates insights from the project kick-off meeting held on November 23rd and 24th, 2023. Under the Management and Coordination work package (WP1), Deliverable 1.1 aims to provide a comprehensive framework for the project's structure, work plan, and management approach. It focuses on ensuring timely task completion, appropriate resource allocation, and achieving high-performance/quality results to support the partnership's scientific and technical objectives. The Project Management Plan (PMP) plays a central role in detailing how project aspects are managed, monitored, and controlled, emphasizing efficient decision-making and adaptability. Deliverable 1.1 also serves as a central reference for reporting protocols, functioning as a manual for Consortium members' day-to-day activities, establishing standardized operating procedures and methods for document provision, ensuring efficient project implementation

**Table 1: The Consortium of the SOMMER project**

| No. | Short name | Organization name | Country | Type |
|---|---|---|---|---|
| **1** | DLR | Deutsches Zentrum Für Luft- und Raumfahrt e.V. | DE | Research Centre |
| **2** | FZJ | Forschungszentrum Jülich GmbH | DE | Research Centre |
| **3** | IREC | Fundacio Institut De Recerca De L'Energia De Catalunya | ES | Research Centre |
| **4** | HTE | HTE GmbH The High Throughput Experimentation Company | DE | Industry |
| **5** | CSIC | Agencia Estatal Consejo Superior De Investigaciones Científicas | ES | Research Centre |



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| | | | | |
|---|---|---|---|---|
| **6** | MAM HW | Morgan Advanced Materials Haldenwanger GmbH | DE | Industry |
| **7** | TITAN | TITAN Cement Company S.A. | GR | Industry |
| **8** | BASF | BASF SE | DE | Industry |

This consortium brings together expertise from leading research institutions and industries in membrane technology, solar technology, materials science, modelling, chemical technology, and catalysts. Importantly, the end user's perspective is also included in the consortium.

Each partner plays essential roles, contributing to different work packages (WPs), fostering knowledge transfer, and creating positive synergies. The collaborative organization ensures that each partner is committed to specific WPs, and conversely, each WP benefits from input from different institutions. This strategic collaboration promotes the seamless integration of expertise and resources from various fields to address the multifaceted challenges (see Figure 1) of the SOMMER project. The partners' geographic spread (Figure 2) spans Europe, including countries along the solar belt (Spain, Greece), ensuring the appropriate dissemination of project results.

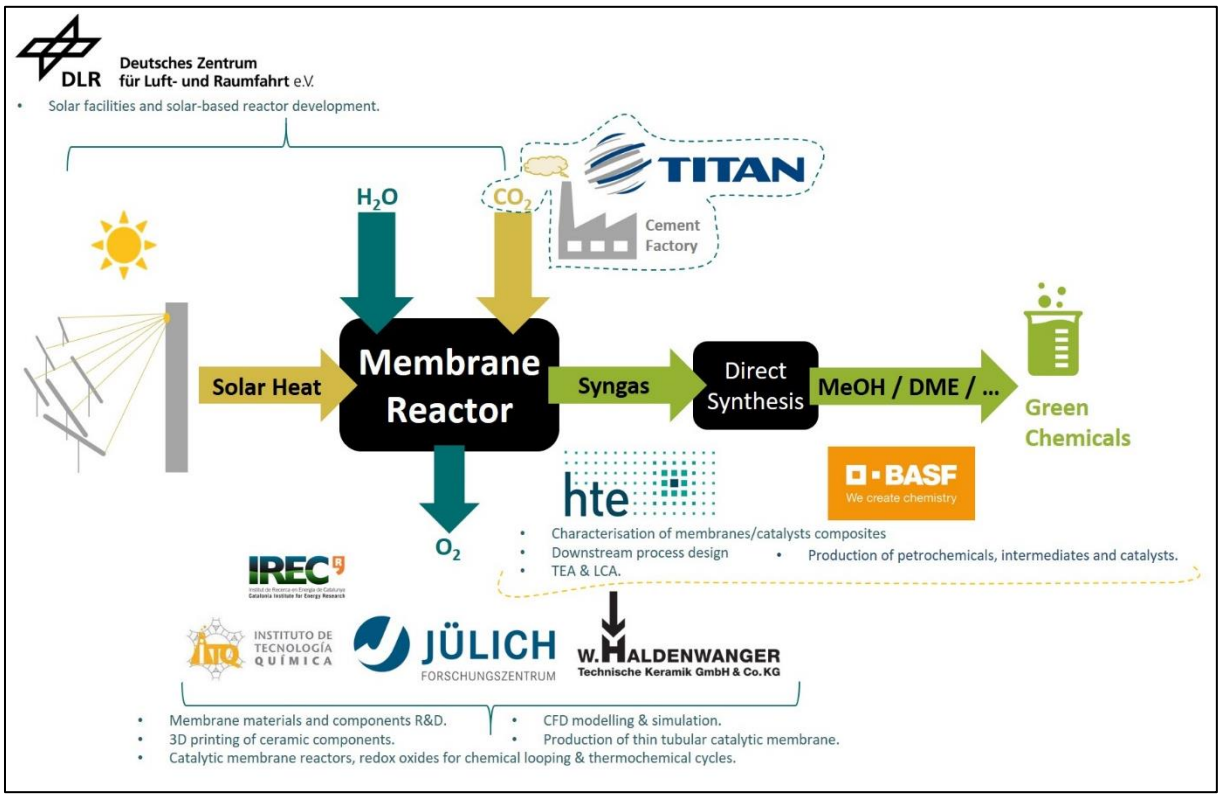


**Figure 1: SOMMER consortium's value chain**



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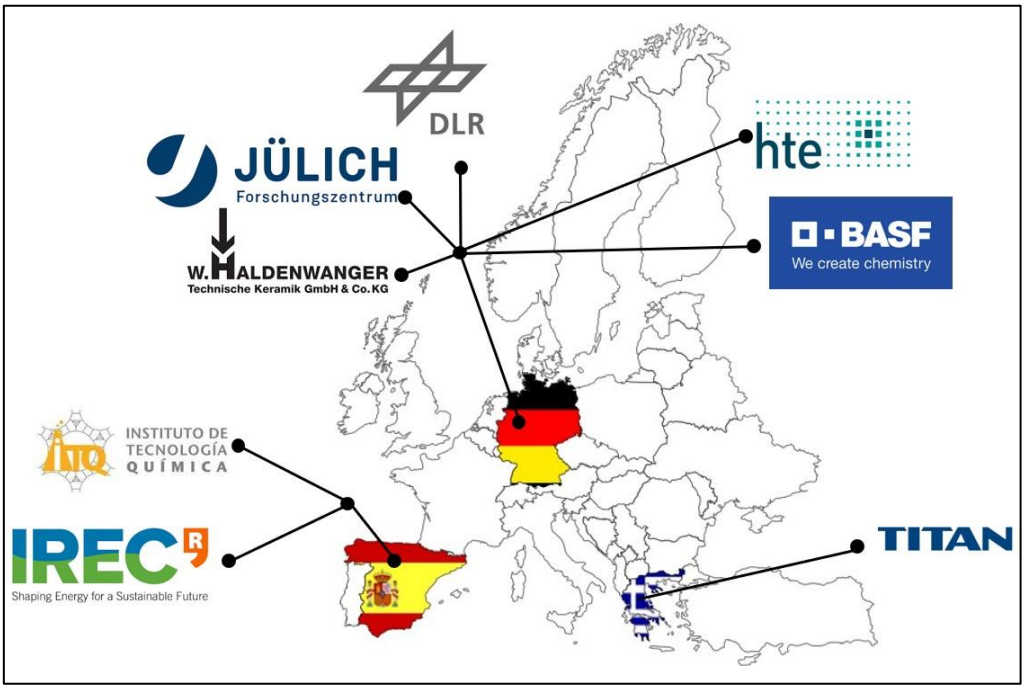


**Figure 2: Geographical distribution of project's consortium**

# 3. Establishment of Project Management and Governance Structure

The project's Organisational, Management, and Governance structure adhere to standard industrial-oriented R&D practices, specifically tailored for similar-sized multi-partner projects. The efficient and results-oriented management principles of SOMMER address the project's multi-disciplinarily and complexity. The aim is to ensure fair representation, flexibility, and transparent governance at all levels of management. As outlined in **Task 1.1, Establishment of project management and governance structure** of the DoA, the project's management hierarchy encompasses three levels: **Project, Work-Package,** and **Task**. Each level has designated Management bodies responsible for assessing progress, results, and making major technical, policy, and management decisions.

## 3.1. Project Level

At the Project Level, management involves collaboration among three key entities: the General Assembly, the Project Coordinator, and the Exploitation Committee. Figure 3 schematically depicts this Management structure, detailing the composition, mission, and key aspects of the decision-making process. Comprehensive details, including quorum requirements and voting procedures, are outlined in the **Consortium Agreement (CA)**, which has already been signed.



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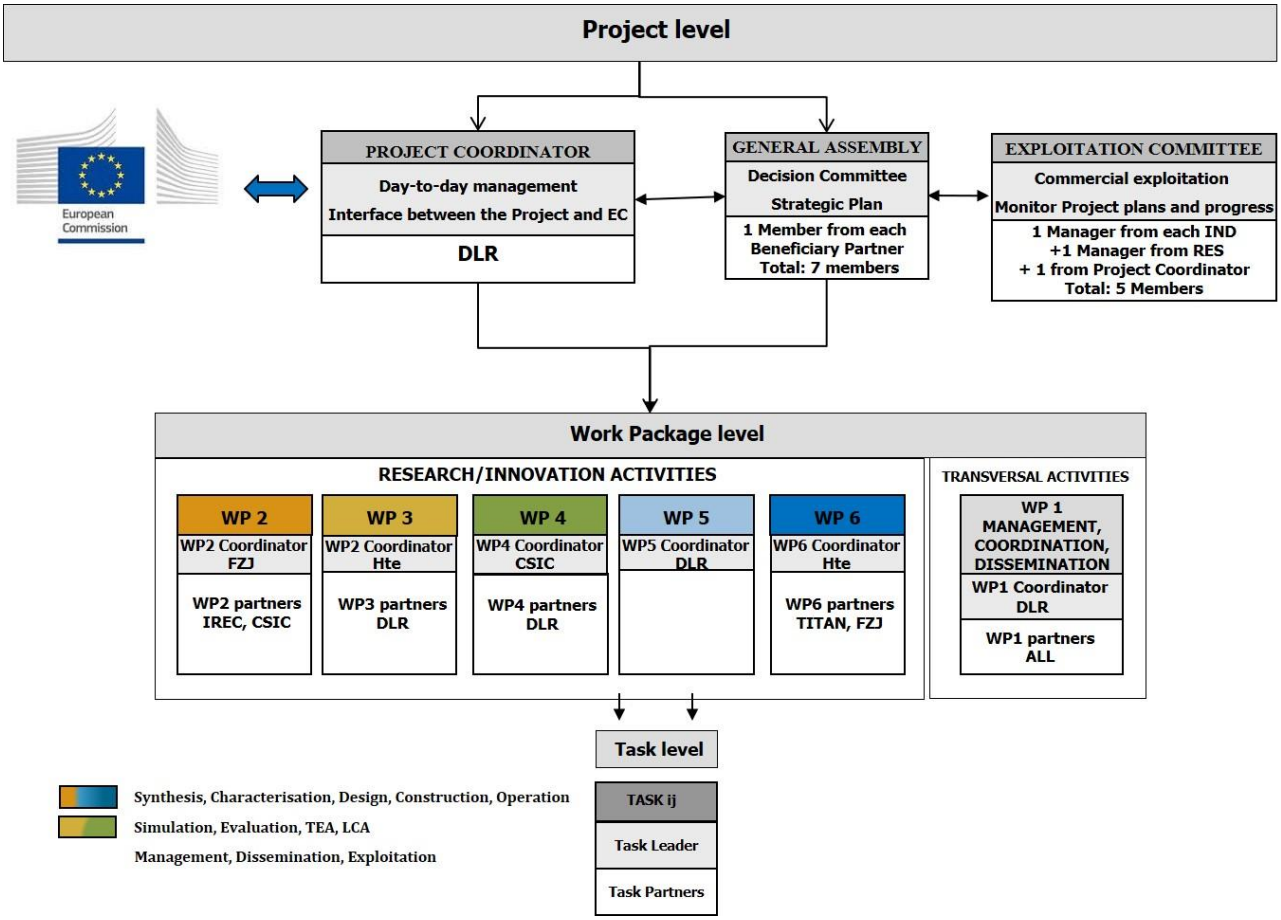


**Figure 3: SOMMER project management structure at the Project Level.**

### 3.1.1. General Assembly (GA)

The **General Assembly** (GA) comprises one representative from each beneficiary partner, **totalling 7 members**. Each participating organization has designated one 'regular' member and a Deputy/Proxy as a backup in case the former cannot participate. Table 2 provides a detailed description of the composition of the project's GA based on these appointments.

**Table 2: SOMMER General Assembly**

| No. | Organisation | Member | Deputy / Proxy |
|---|---|---|---|
| **1** | DLR | N. Neumann | A. Eltayeb |
| **2** | FZJ | S. Baumann | W. Meulenberg |
| **3** | IREC | M. Torrell | A. Tarancón |
| **4** | Hte | S. Schunk | I. Jevtovikj |
| **5** | CSIC | M. Balaguer | A. Carrillo |
| **6** | MAM HW | M. Rozumek | F. Luthardt |
| **7** | TITAN | M. Katsiotis | tbd |



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This body plays a crucial and strategic role, aiming to steer research efforts toward efficient solutions and practical market applications. The GA will conduct high-level assessments of results from diverse research endeavours and make pivotal decisions. This involves defining and calibrating various aspects, including but not limited to:

- Workplan calendar and progress monitoring measures
- Budget distribution, financial issue review, and approval
- Efficient partnership communication channels
- Effective self-assessment methodology, monitoring the quality management plan, and approving the risk assessment
- Strategic dissemination strategy
- Conflict resolution management

The GA holds the authority to decide on the inclusion of new sub-programs as the project progresses, launch calls for tenders, and invite experts to its meetings as advisors. The Project Coordinator serves as the GA chair, unless otherwise decided by the GA. The Project Coordinator is responsible for convening GA meetings as needed, setting agendas, chairing meetings, and ensuring partners implement GA decisions. Except for matters requiring a unanimous vote (detailed in the Consortium Agreement), GA decisions are based on a majority, i.e., 2/3 of all GA members' votes. Each GA member is empowered by their organization to commit staff and other resources as per the agreed contract. Changes to the work program are discussed and decided upon by the GA for submission to the EU.

## 3.2. Exploitation Committee (ExCo)

The composition of the Exploitation Committee is designed to ensure the swift exploitation of project results by the industrial partners. The ExCo is formed by appointing one manager from each beneficiary industrial partner involved in the consortium (Hte, MAM HW, and TITAN), one from the coordinator (DLR), and a representative chosen from the remaining three research partners (FZJ, IREC, and CSIC) through an election process – totalling 5 members. FZJ and IREC have volunteered to represent the 'regular' member and the proxy/deputy of the research partners, respectively. This proposal has received unanimous agreement from all other research organizations. Accordingly, the project's Exploitation Committee has been structured as outlined in Table 3.

The role of the ExCo will be to **monitor the plans and progress of the Project** and **advise on all issues** relating to the commercial exploitation, the input to standards, the input to EU policy, on further research and education and on social goods as well as on the implementation of the Innovation Management and the Exploitation activities.



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**Table 3: SOMMER Exploitation Committee**

| No. | Organisation | Member | Deputy / Proxy |
|---|---|---|---|
| **1** | DLR | A. Eltayeb | N. Neumann |
| **2** | FZJ | S. Baumann (FZJ) | M. Torrell (IREC) |
| | IREC | | |
| | CSIC | | |
| **3** | Hte | S. Schunk | I. Jevtovikj |
| **4** | MAM HW | F. Luthardt | M. Rozumek |
| **5** | TITAN | M. Katsiotis | tbd |

# 4. Work Package Level

## 4.1. Work Package Leaders

The technical management and responsibility for each work package (WP) is assigned to a partner from the group of participants, who nominates the person responsible on their behalf from their staff - the WP leader (WPL). The WPLs of the project are listed in The WPLs are responsible for each work package and ensure the timely completion and submission of deliverables, milestones, reports, etc. They are also responsible for the **day-to-day scientific coordination of WP tasks** and facilitate communication between tasks and between the WP and the project coordinator. They are responsible for the detailed coordination, planning, monitoring and reporting for the work package as well as for coordination with other work packages of the project. The partners involved in a WP may meet under the chairmanship of the WPL, depending on the specific needs of the WP.

Table 4. The WPLs are responsible for each work package and ensure the timely completion and submission of deliverables, milestones, reports, etc. They are also responsible for the **day-to-day scientific coordination of WP tasks** and facilitate communication between tasks and between the WP and the project coordinator. They are responsible for the detailed coordination, planning, monitoring and reporting for the work package as well as for coordination with other work packages of the project. The partners involved in a WP may meet under the chairmanship of the WPL, depending on the specific needs of the WP.

**Table 4: SOMMER Work package Leaders.**

| **Work Package** | **WP Leader/ Organisation** |
|---|---|
| 1. Project management, coordination and dissemination | Asmaa Eltayeb - DLR |
| 2. Development & Manufacturing of Membrane Components | Stefan Baumann - FZJ |
| 3. System Analysis: Economics, Energetic, Environmental | Stephan Schunk - HTE |
| 4. Simulation of a Solar Membrane Reactor | Maria Balaguer - CSIC |
| 5. Experimental Validation Under Solar Irradiation | Nicole Neumann - DLR |
| 6. Innovation Staircase | Stephan Schunk - HTE |



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**Each organisation involved in a WP has defined the person responsible on its behalf for the specific WP** - who will also be the main contact point for the partners involved in the WP - as well as an alternative contact person. This WP responsible on behalf of the organisation, can distribute the organisation's work within the specific WP internally to further personnel. According to that arrangement, common, internal mailing lists per each WP have been created for inter-WP-communication, limited to maximum of two people from each organisation to maintain efficiently small groups and effective dissemination of information avoiding information overload and excessive mailing lists. Table 5 is a typical such table for WP2; similar tables have been formed for each WP.

**Table 5: SOMMER intra-WP dissemination list, WP2.**

| No | Partner | Name | Description |
|---|---|---|---|
| **1** | DLR | Asmaa Eltayeb | Main contact, Project Coordinator |
| **2** | DLR | Nicole Neumann | Alternate Contact |
| **3** | FZJ | Stefan Baumann | Main contact, WP2 Leader |
| **4** | FZJ | Kevin Streckel | Alternate Contact |
| **5** | FZJ | Jürgen Malzbender | Alternative Contact |
| **6** | IREC | Marc Torrell | Main contact, WP2 responsible on behalf of organisation |
| **7** | IREC | Albert Tarancón | Alternate Contact |
| **8** | Hte | Stephan Schunk | Main contact, WP2 responsible on behalf of organisation |
| **9** | Hte | I. Jevtovikj | Alternate Contact |
| **10** | CSIC | Maria Balaguer | Main contact, WP2 responsible on behalf of organisation |
| **11** | CSIC | Alfonso Carrillo | Alternate Contact |
| **12** | MAM HW | Fabian Luthardt | Main contact, WP2 responsible on behalf of organisation |
| **13** | MAM HW | Michael Rozumek | Alternate Contact |
| **14** | TITAN | Mario Katsiotis | Main contact, WP2 responsible on behalf of organisation |
| **15** | TITAN | tbd | Alternate Contact |
| **16** | BASF | tbd | Main contact, WP2 responsible on behalf of organisation |
| **17** | BASF | tbd | Alternative Contact |

# 5. Task Level

## 5.1. Task Leaders (TL)

An organisation is designated as the Task Leader (TL) for each task within each WP. Each TL is responsible for the Task supervision and implementation, and must communicate relevant information, such as technical reports, to the respective WP Leader. The TLs are direct responsible for the detailed planning and day-to-day execution required to carry out tasks related to specific activities.



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### 5.1.1. Interrelation and Complementarity

Based on the above, the interrelation and complementarity among the various management entities is now clear. The **GA** is the decision-making body with power to make decisions on: (i) direct the strategic orientation of the project, (ii) allocate and distribute the budget; (iii) inclusion of new partners and (iv) exclusion of partners (based on relevant provisions and procedures of the CA).

The **Project Coordinator** is an operational body between the EC and the partners, whereas the **Exploitation Committee** assumes the commercial exploitation of the research results. The day-to-day management of the project is implemented by the PC and the WP leaders appointed. Interrelation among the technical content of the WPs is "enforced" by the Project Coordinator, whereas on the Administrative level, the General Assembly in addition to the regularly scheduled meetings, shall convene extra Technical Meetings among relevant or interconnected WP leaders in order to promote exchange of information on progress made and on ways to tackle common problems. Within each WP, the WPL is responsible for initiating and implementing such intra-WP meetings to address relevant WP issues.

The organizational structure and decision-making mechanisms of SOMMER are based on common practices, already successfully employed in EC collaborative projects. All participants are familiar with the current organisational structure, facilitating the management of contractual obligations at the coordination and administrative levels. This includes the planning of WP activities, coordination of tasks, meetings, and reporting within the consortium and toward the EC. Simultaneously, the proposed structure maintains a flexible and efficient approach (e.g., day-by-day communication between partners via emails, teleconferences, or technical meetings) to promptly address the complex requirements of scientific and technical advances and determine the most suitable solutions for challenging items identified during the project.

# 6. Project Internal Communication Tools

## 6.1. Project TeamSite

For efficient communication and exchange of information among the partners, a TeamSite has been created by the Project Coordinator, DLR in its own intranet domain. This TeamSite is different than and should not be confused with the Project's website that is going to be used for public dissemination of the project's results (a Deliverable of WP1, currently under construction). The project's secure TeamSite is administered by the coordinator and colleagues from all partners that are involved in any of the project's WP have been granted password-protected access to it and capability of uploading/downloading documents. The TeamSite functions also as a repository of draft and finalised documents, templates, presentations, information, etc.; all such documents can be stored and exchanged therein. Typical such documents included already are the project's Kick-Off Meeting minutes and presentations; naturally, draft and final versions of Deliverables and Progress reports will be included therein in due time. Again, to avoid over-expansion, is divided in only 6 subfolders corresponding to the project's WPs. A screenshot of the TeamSite's user interface is shown in Figure 4.



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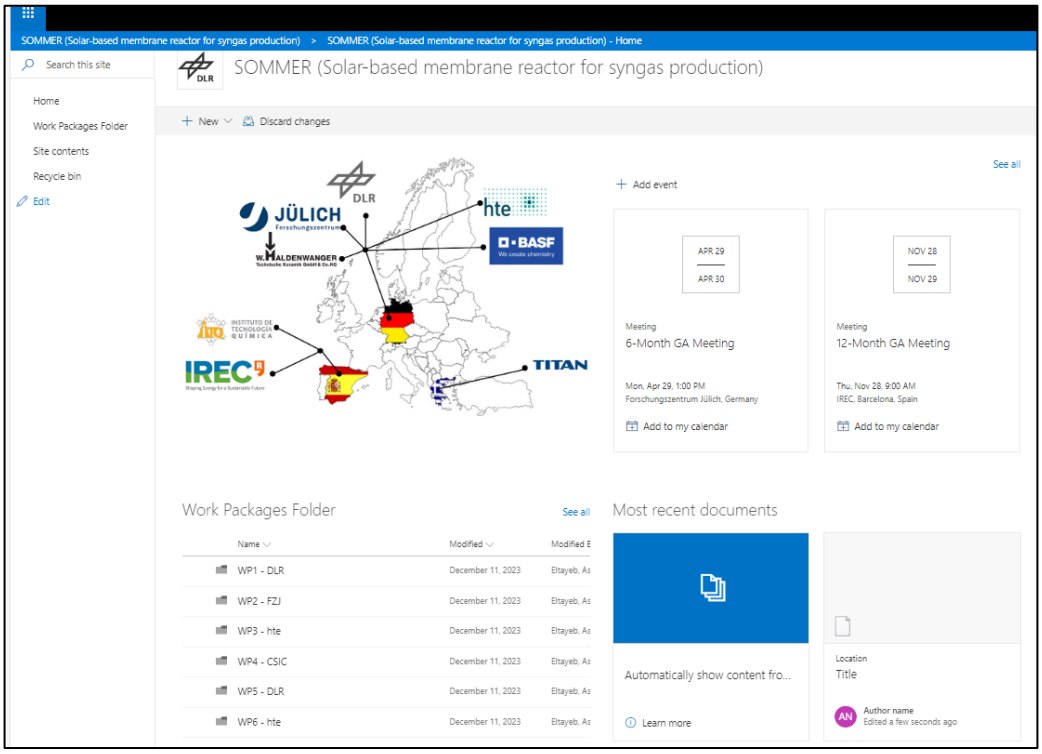


**Figure 4: Screenshot of SOMMER's TeamSite.**

# 7. Project Meetings

## 7.1. Physical Meetings

The project coordinator is responsible for the organisation of regular physical meetings of the whole consortium to secure the internal communication of the project. The meetings of the whole consortium will be organized **twice a year**, at the premises of each different partner each time, pandemics-permitted and following the sequence of the project's tasks evolution. The representation of each project partner in such meetings is mandatory.

## 7.2. Remote Meetings

Besides the physical meetings, the usual teleconferencing tools will be used in order to facilitate an efficient and frequent communication between the regular meetings. In-between the regularly scheduled physical project meetings mentioned above, remote meetings will be employed for the effective communication among project partners during the project. A **regular meeting every 6 weeks** between the **GA and the PC** is required to provide a quick update on the project progress within each WP. It is mandatory that all active WPLs be present during this meeting to report on the progress. The purpose of these meetings is to inform the PC of any new developments, needs of introducing corrective actions and any other issues that will enable a realistic time schedule and ensure that the project is on track towards achieving its objectives and vision. The Project Coordinator is responsible for the organisation of the agenda and for the coordination of such meetings. The meetings' details (day, time, link, agenda) will be communicated by the PC at least one week before the date of each



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meeting, in order to allow time to the participants for scheduling and preparing all necessary information.

The WP leaders organize **WP-relevant meetings** either with physical presence or via teleconferences as frequently as judged to meet the requirements within each WP. Such meetings will be held on an ad-hoc basis, initiated by the respective WPL. It was agreed among the partners to try to hold such a WP meeting (remote preferably than physical) in every ongoing WP according to the Gantt Chart, occurring as frequently as possible but not exceeding a 3-month interval.

In every physical as well as remote meeting, meeting minutes will be taken by a colleague appointed as rapporteur at the start of the meeting. As a general procedure, the draft meeting minutes will be circulated to all partners by the rapporteur within 15 calendar days of the meeting for their approval and comments. The minutes shall be considered as accepted if, within 15 calendar days from sending, no partner has sent an objection in writing.

# 8. Project Deliverables

## 8.1. Official Deliverables

As per Article 21 of the Grant Agreement, beneficiaries are required to provide continuous updates on the action's progress, including deliverables, milestones, outputs/outcomes, critical risks, indicators, etc., through the Portal Continuous Reporting tool, adhering to the specified timing and conditions. The project's list of deliverables, along with their dissemination level (e.g., public, confidential) and due dates, is detailed in Annex 1 of the Grant Agreement (GA-A1), encompassing a total of 30 anticipated deliverables. The schematic representation of the timeline with the due dates for all deliverables is illustrated in Figure 5. While many deliverables will take the form of reports detailing the work undertaken, even in cases where the deliverable involves a physical demonstrator, software, a database, document, or publicity material, a corresponding report summarizing the relevant work will be generated and uploaded to the EC Participant Portal.

## 8.2. Deliverables Format

A template for deliverables is uploaded to the TeamSite to allow for uniform deliverables format among all partners. Each deliverable should follow a set structure as set out in the templates of:

- A cover page with the project's logo (when it becomes available), the title of the deliverable, its due date and the relevant work package, followed by a table denoting all other relevant information, like Revisions, Authors, Nature of Deliverable, Dissemination level, etc. as in the present document.
- Abstract (and public abstract if confidential document)
- Table of Contents (if deemed necessary)
- Introduction – an outline of the aims and objectives of the deliverable, explaining in parallel its interdependences with other tasks and deliverables (e.g. inputs/outputs to/from other tasks).
- Main body of the report, explaining the results generated and illustrating the technical and scientific progress made.



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- Conclusions summarizing the major outputs of the deliverable and the implications of the results on other parts of the project, highlighting their impact for end-users, scientific community, and/or the general public. In addition. The conclusions should also address any deficiencies in the work carried out and where future improvements or further work should be directed.
- References
- Appendices (if needed, including data or information not suitable for the main body of the report either due to its detailed nature or due to confidentiality reasons).
- Deliverables will be tracked by the Project Coordinator, identifying those due in the near future, the deadlines for each deliverable, follow-up actions and the names of the persons producing and reviewing them. The PC will report this progress to the General Assembly at the relevant meetings.

# 9. Reports

## 9.1. Official Reporting

According to Article 21.2 of the Grant Agreement, the project is divided into three reporting periods (RPs) as follows:

- 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 one Final Report are due in total. The Reports are mandatory and linked to interim and final payments by the granting authority. The reports should:

- Answer questions in the template
- Describe the activities carried out during the implementation
- Be in line with the project's grant agreement
- Describe the risks encountered and mitigation measures applied
- Be concise, clear and not ambiguous
- Include quantified results where possible

The periodic and the final reports contain

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

The requirements and contents for each one, are described in the Grant Agreement.



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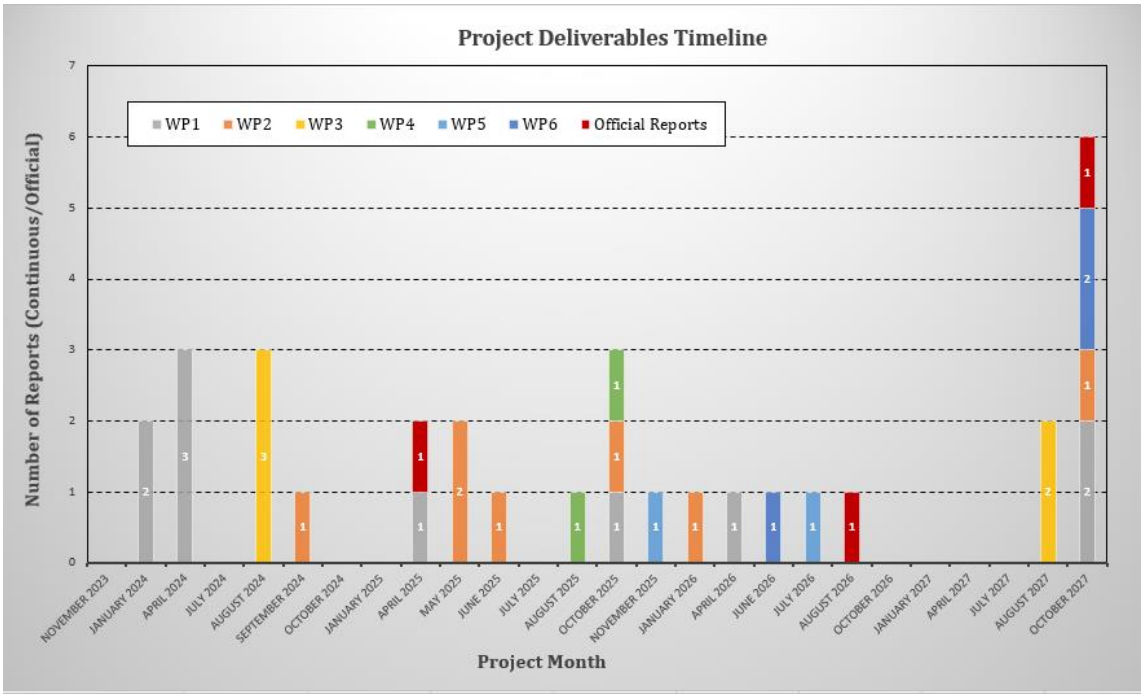


**Figure 5: SOMMER's Deliverables Timeline per WP & Official Reports.**

## 9.2. Project Reviewing Meetings

At the end of each reporting period and in association with the submission of the relevant progress reports, the Project Coordinator will organize three respective Project Review Meetings among all partners, the EC officer and possibly external experts invited by the EC. Taking into account the 60-days maximum period allowed for the submission of the periodic reports and a reasonable time for the EU officer and any external reviewer(s) to assess them, such Project Review Meetings are tentatively foreseen for M22, M33 and M48 from the date of the Project's commencement. (The final review meeting will take place before the submission of the Final Report since the costs incurred after the end of the project related to the final review meeting and completion of the report are eligible as long as the report is not submitted until the review meeting has taken place).

The purpose of these meetings will be to report on the progress of the work to date and the partners' plans for future exploitation strategy and to redefine (if necessary) the Project Programme for the remaining part of the contract. Procedures for managing future exploitation of results will be discussed and assessed. Depending on the progress and the results achieved, a change in the work-programme may be proposed. Alternatively, in case of insufficient technical results or poor outlooks for further exploitation, it can be decided to discontinue the project. The continuing existence of positive and realistic perspectives for the exploitation of the results and the continuing commitment of the partners to the objectives of the project will be a key requirement for the continuation after the Assessment Meetings. Crucial Milestones have been set for before all Assessment Meetings to be used as a measure for such decisions.



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# 10. Project Planning

The overall project planning comprises two essential components: the Work Breakdown Structure (WBS), outlined in section 10.1, and the Gantt chart discussed in section 10.2. The WBS is derived from the Pert diagram illustrated in Figure 4(a), providing a comprehensive overview of all relevant Work Packages (WPs) and visualizing their interaction across the project's timeline. This planning will be continuously updated throughout the project's duration and utilized by the coordinator to monitor the progress of work tasks, ensure the timely preparation of deliverables, and achieve milestones.

## 10.1. Work Breakdown Structure (WBS)

SOMMER is planned as a 48-month project, consisting of five Research/Innovation Work Packages (WP2-WP6), addressing the technical activities required for the development of the project's innovative ideas. Additionally, there is one WP dedicated to management, coordination, and dissemination (WP1), including actions for the exploitation of the project's outcomes.

The interrelation among the WPs is visualized in the respective Pert chart (Figure 4(a)). The Work Breakdown Structure (WBS) in Figure 4(b) illustrates that WP1 (management, coordination, and dissemination), depicted at the top, serves as the leading work package steering all others. It also encompasses the main goal of the project, involving the protection, exploitation, dissemination, and communication of scientific results. Therefore, WP1 represent the framework, while the core of the project consists of work packages 2 to 6. All investigations ultimately lead to a technology proof-of-concept demonstration in WP5, making this WP particularly crucial. The overall evaluation of the process occurs in WP3 and WP6. Throughout the project, results from strongly interlinked WPs lead to decision points, providing input for subsequent WPs (indicated in yellow boxes in Figure 4 (b)).

**WP1 Project Management, Coordination, and Dissemination,** extends throughout the project duration. It deals with the management and scientific coordination of legal, administrative, financial, and contractual tasks. Additionally, it includes activities related to knowledge management, exploitation, dissemination, and communication, both within and outside the partnership. These activities aim to highlight the project's scientific, industrial, and social relevance by communicating its results to the scientific/industry community, opinion-makers, and the wider public.

**WP2 Development of Membrane (Material and Manufacturing)** starts at the Project's beginning and is dedicated primarily to membrane development and evaluation. This includes the selection of membrane and catalyst materials suitable for high temperatures (approximately 1500°C) and intermediate temperatures (around 900°C). WP2 activities, closely coordinated with WP4 on reactor modelling, encompass material selection, surface functionalization, synthesis, and lab-scale analysis. Pre-selected materials undergo experimental evaluation for feasibility in solar reactor conditions, guiding their selection for further processing. Final components are produced and tested in WP5. WP2 contributes crucial data for the life cycle assessment (LCA) and techno-economic assessment (TEA) in WP3.

**WP3 System Analysis: Economics, Energetic, Environmental** starts at the Project's beginning and is divided into two parts. The first part, spanning the initial 10 months, aims to define the operational



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parameters of the membrane reactor, including temperature and pressure, and downstream processes such as syngas ratio and required conditioning. The second part, commencing from 28-month and extending until the project's conclusion, involves the comprehensive assessment of the entire process through Techno-Economic Analysis (TEA) and Life Cycle Assessment (LCA). This two-part approach ensures a thorough understanding of the operational aspects early in the project, followed by an in-depth evaluation of the overall process in terms of economic, energetic, and environmental considerations later in the project timeline.

**WP4 Simulation of Membrane Reactor,** spans 21 months and kicks off in Month 3 of the project. The primary objectives of WP4 are twofold. First, it involves the identification of optimal operational conditions, considering competing reactions on both the feed side and permeate side of the membrane reactor. The goal is to maximize the yield for a specific $H_2$/CO ratio. Additionally, WP4 plays a crucial role in supporting the membrane and reactor designs. For membrane design, it focuses on determining the optimal geometry of 3D-printed membranes, considering $O_2$-permeation and kinetic data provided in WP2. Regarding reactor design, WP4 aims to determine the upper temperature limits of reactor components and ensures the homogenization of solar irradiation to prevent hot spots on the membrane. The construction of Multiphysics models for the membrane reactor, utilizing $O_2$-permeation and kinetic data from WP2, is a key component of the first activity. The second activity involves modelling the membrane reactor under solar irradiation to establish the optimum geometric design, balancing radiation heat transfer from the solar source and fuel production efficiency. The outcomes of these modelling tasks are pivotal for the development of a more efficient solar membrane reactor, which will subsequently be designed, constructed, and tested in WP5.

**WP5 Experimental Validation Under Solar Irradiation** spans from Month 3 to Month 44 of the project and involves three integral phases. The first and second phases focus on the design and construction of a membrane reactor, incorporating a minimum of two tubular membranes seamlessly integrated for simulated solar power of 5 kW, respectively. The third phase is dedicated to the proof of concept and validation of the performance of primary process materials and components under simulated solar irradiation. This entails a meticulous evaluation of syngas production using the prototype membrane reactor under different scenarios, including Case I at 1500 °C and Case II with co-feeding biogas at 900 °C, incorporating diverse membrane and catalyst materials, geometries, and morphologies. This phase also involves varying operational conditions, such as temperature and flow rates of feed gas and permeate gas (sweep, hydrocarbons), to optimize reactor efficiency and identify potential limitations due to unwanted by-products like coke. Through these comprehensive phases, WP5 aims to provide empirical validation and crucial insights into the performance, efficiency, and limitations of the developed solar membrane reactor.

**WP6 Innovation Staircase** unfolds later in the project, commencing in Month 25 and continuing until the project's conclusion. The primary objective of WP6 is to delineate the trajectory along the innovation ladder, aiming to elevate the Technology Readiness Level (TRL) for solar-driven membrane reactors. This pathway is informed by insights from the systems analysis conducted in WP3 (TEA, LCA), the experimental demonstration in WP5, and the collective lessons learned from all work packages. An additional goal is to outline the industrial realization of project outcomes, identifying optimal



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opportunities for advancing the technology. Challenges and opportunities will be scrutinized, particularly regarding materials, design, and fabrication of membrane modules and their integration into industrial processes, such as cement production. Moreover, WP6 will evaluate alternative (typically more complex) membrane concepts found in the literature, drawing on the outcomes and experiences gained within the SOMMER project. The culmination of SOMMER's findings will be consolidated into a roadmap, providing a strategic guide for the future development and implementation of solar-driven membrane reactor technology.

The research work packages (WPs) can be schematically categorized into membrane, reactor, and process-related WPs/Tasks (see Figure 4a). On membrane level, works within WP2 will lead to a material selection for the membrane and catalysts to be later on manufactured. Functional tests will support this selection step. The material selection will be in a feedback-loop with WP4 and WP3, where the reactor concept and the operational parameters are defined within the first phase of the project. After the material selection, additive and conventional manufacturing process will be addressed at lab-scale. In parallel, the reactor model and the reactor design will be developed in WP4 and WP5, respectively. During the final design of the solar membrane reactor, the manufacturing of mixed-ionic-electronic conducting membranes is scaled up in order to provide the membrane units for the reactor proof-of-concept testing. The interrelated work on reactor-level in WP4 and WP5 will lead to a final reactor design to be constructed at DLR. In parallel, the economic and ecological assessment will begin based on the selected reactor concepts and also considering kinetic data generated in WP2. In addition, the performed solar experiments will provide valuable process information to WP3 for the economic and ecological system assessment, as well as hint at future development steps needed in WP6. After the solar tests, the membrane units are to be provided to WP2 for a post-mortem analysis.

In this context, the project can be schematically subdivided into three phases:

**Phase 1 (Months 1-24):** Focus on materials selection, concept development, definition of operational conditions, and design of the membrane reactor, involving WP2, WP3, WP4, and WP5.

**Phase 2 (Months 25-34):** Completion of membrane manufacturing, final design, and assembly of the solar membrane reactor within WP5. Additionally, this phase includes further optimization and testing of membrane units in WP2, initiation of the integration of technology into a cement plant (WP6), and the commencement of TEA/LCA in WP3.

**Phase 3 (Months 35-48):** Focus on final modifications and the commencement of the experimental campaign for the solar membrane reactor in WP5, running in parallel with an overall TEA and LCA in WP3.



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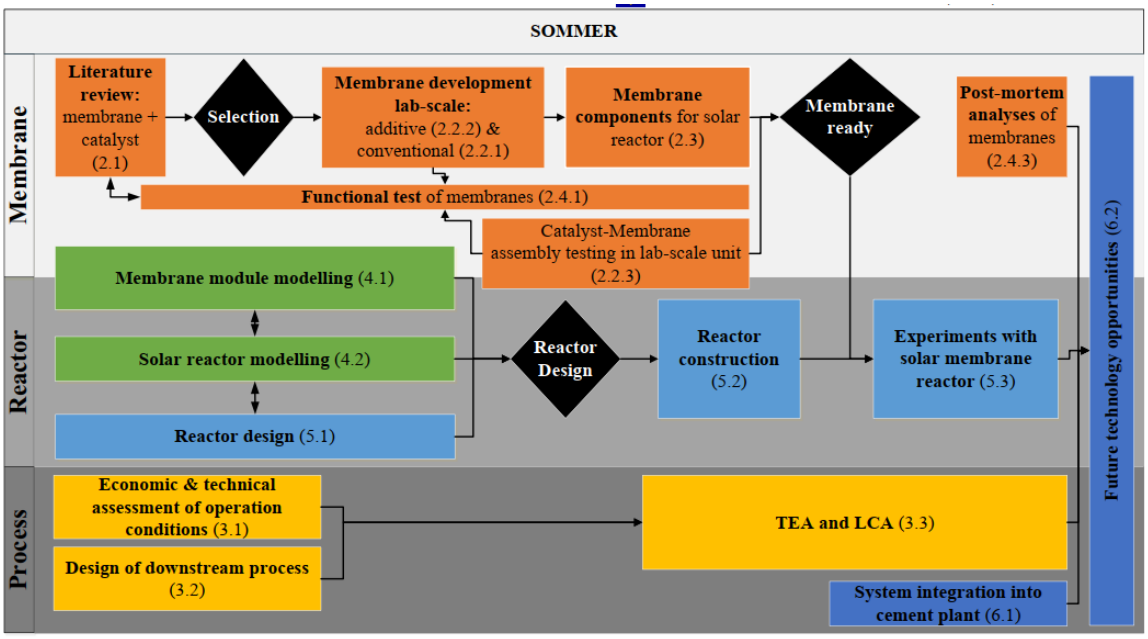
(a)




(b)

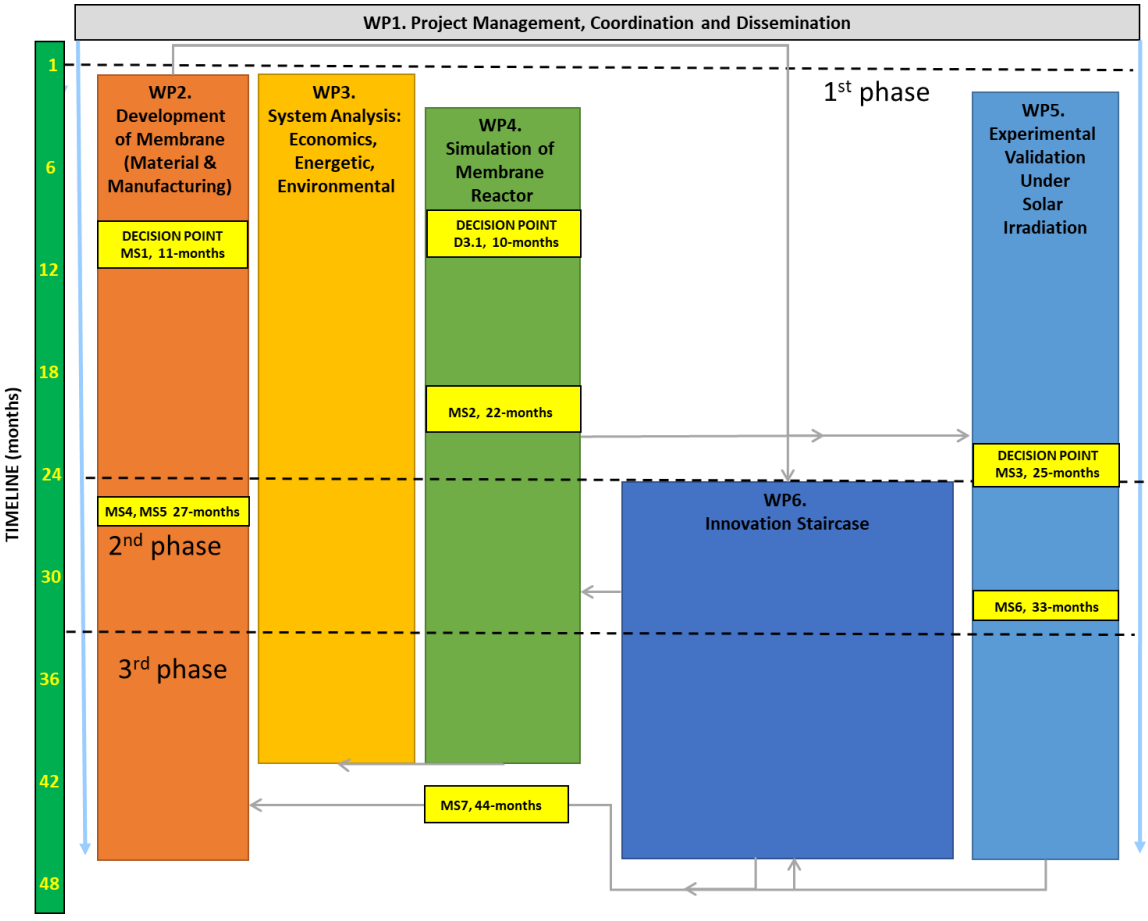



**Figure 4: (a) Flow diagram and (b) Work break down structure (WBS) of the project.**



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## 10.2. Gantt Chart

The project work, outlined in the Work Breakdown Structure (WBS) of the previous section, is spread over four years, from November 2023 to October 2027, as shown in Figure 5. The project design, simulation and environmental impact assessment components (WP3, WP4 and partly WP5) start at the beginning of the project and form the basis for the assessment of the overall process at the end of the project. The technical core, WP2, begins concurrently, followed by WP4 after three months, focusing on the modelling of the solar membrane reactor. By September 2024, the project achieves its first milestone and decides on the selection of the final redox composition (milestone M1 in WP2). Another milestone, M2 in WP4, is due in August 2025 (22 months into the project), focusing on the optimal design of the membrane modules. Six months later, in December 2025, the operating parameters of the reactor as well as the final design and dimensions are determined. Two months later, in January 2026, the fully cast and 3D-printed membrane components are delivered for use in the membrane reactor developed in WP5. In month 33, i.e. July 2026, the assembly of the membrane reactor will be completed and the unit will be installed for operation under the high-flux solar simulator at DLR in Cologne to reach milestones M6 in WP5. Finally, the proof-of-concept test of the membrane reactor unit must be completed four months before the end of the project, in August 2027, in order to reach milestone M7 in WP5. This will provide the final data for the life cycle assessment (LCA) of the overall concept and the techno-economic assessment in WP3, which will achieve milestone M7.



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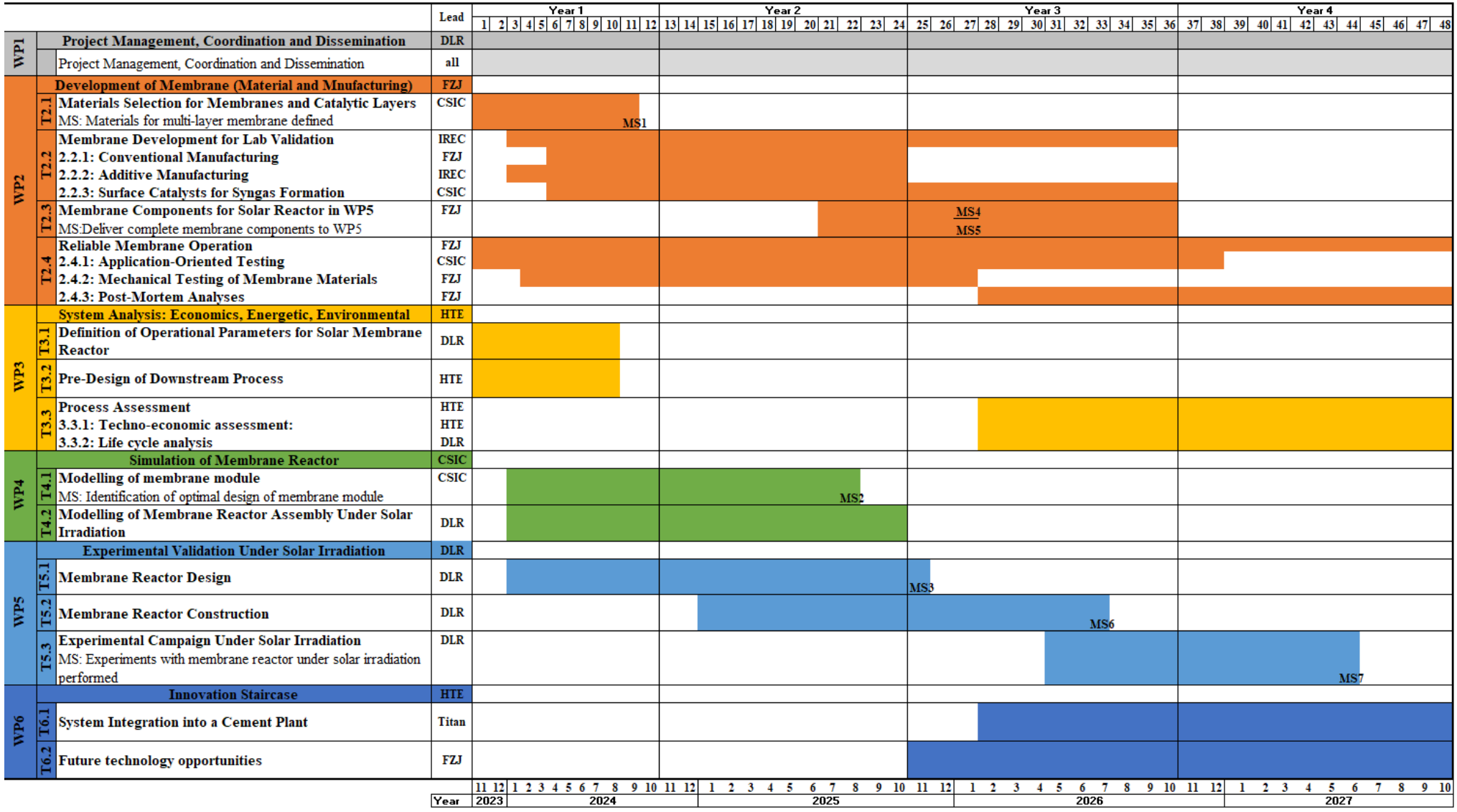


**Figure 5: SOMMER Project Gantt Chart**

# 11. Conclusion

After the project kick-off meeting, a comprehensive Project Management Plan (PMP) was developed, detailing the project's structure, decision-making bodies, work plan, and overall management approach. The PMP also outlines the established channels of internal communication and includes provisions and guidelines for partners to ensure the project's smooth implementation and timely submission of deliverables to the European Commission.

Scheduled internal reports and milestones are integral components of the PMP, complementing the contractual obligations of deliverables and official reporting. These measures facilitate close monitoring of project activities from the project's early stages. An updated Gantt chart and Work Breakdown Structure (WBS) are incorporated into the PMP, providing a clear and comprehensive overview of relevant work packages, their interactions, and key decision points throughout the project.

The PMP serves as the framework within which project planning occurs, ensuring effective management, monitoring, and control of all project activities. D1.1 establishes the groundwork for managing the project to achieve high-quality results delivered in a timely and efficient manner.