


TECHNICAL REPORT (PART B)**COVER PAGE**

PROJECT	
Project number:	101058481
Project name:	SUNER-C: SUNERGY Community and eco-system for accelerating the development of solar fuels and chemicals
Project acronym:	SUNER-C

REPORTING PERIOD	
 Please note that you must report on the entire reporting period.	
RP number:	1
Duration:	from 01/06/2022 to 30/11/2023

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1. EXPLANATION OF THE WORK CARRIED OUT AND OVERVIEW OF THE PROGRESS

1.1 Objectives

The SUNER-C CSA aims to consolidate knowledge and establish framework conditions for overcoming challenges in solar fuels and chemicals. It seeks to transition technologies from the lab to large-scale industrial use, aligning with the EU's net-zero emissions goal by 2050. SUNER-C supports an existing research and innovation community, the SUNERGY initiative, with the overarching objective of developing affordable manufacturing processes for solar fuels and chemicals. The long-term aim of this R&I effort is to decouple economic growth from the use of natural resources.

The main expected outcomes of the SUNER-C CSA are 1) Develop the currently scattered stakeholder landscape into a structured, inclusive pan-European innovation eco-system across fields, sectors and disciplines, enabling better cooperation between community members (>600 stakeholders) and coordination among RD&I projects (indic. 50 R&I projects) and initiatives, around a joint vision; 2) Develop a broadly endorsed roadmap, based on identified R&I challenges, providing directions of the field for the period 2022-2050; this will enable focusing efforts and investments (public and private) in a coordinated way and prevent duplications, thereby speeding up innovation; 3) Prepare a large-scale R&I initiative (LSRI) to tackle long-term research challenges, as mandated by the EC; and 4) develop tools, mechanisms and actions to promote communication, dissemination and education in support of O1-3. To this aim, this project consists of 8 closely interconnected work packages. The table below summarizes the progress made in Reporting Period 1 (RP1) towards the deliverables and milestones outlined in Annex 1 to the grant agreement.

Legend for deliverables and milestones:													
Not in RP1													
Achieved as planned													
Achieved with delay approved by PO (D1.1, D5.3, D7.1, MS1, MS2 see text below)													
In progress (D8.2, Interim progress report 1, this document)													
WP	Work packages and tasks	Year 1				Year 2				Year 3			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1	WP1 - Creation of an R&I community and eco-system												
	T1.1 - Shared vision				D1.1		MS1						
	T1.2 - Community mapping						MS3						
	T1.3 - Structuring the stakeholder landscape into an eco-system						D1.2						D1.3
2	WP2 - Ongoing research activities in the EU												
	T2.1 - Project portfolio						D2.1						
	T2.2 - KPIs and project portfolio monitoring										D2.2		
	T2.3 - Fostering project synergies										D2.2		
	T2.4 - Standardization of protocols												D2.3
3	WP3 - Long-term technological roadmap												
	T3.1 - Technological roadmap						D3.1/MS3						D3.4
	T3.2 - Blueprint												D3.2
	T3.3 - Establishing topics for HE future work programmes												D3.3
4	WP4 - Innovation and Exploitation												
	T4.1 - Exploitation plan				D4.1								
	T4.2 - Framework development for de-risking industrial implementation and supporting societal acceptance of solar fuels and chemicals												D4.2
	T4.3 - European innovation strategy for the LSRI												D4.3
5	WP5 - Dissemination, communication and education												
	T5.1 - Development of the communication and dissemination plan						D5.2		D5.6				
	T5.2 - Organisation of project meetings												
	T5.3 - Implementation of the communication and dissemination plan					D5.1	D5.3						
	T5.4 - Fostering education and create learning resources								D5.4				
T5.5 - Communication and dissemination strategy and plan for the LSRI												D5.5	
6	WP6 - Socio-technical and cross-cutting aspects												
	T6.1 - Identification of the most relevant cross-cutting socio-technical challenges related to SUNER-C and stakeholder affected thereof						D6.1						
	T6.2 - Stakeholder dialogue on implications for transition pathways										D6.2		
	T6.3 - Development of a strategy for integration of cross-cutting issues												D6.3
7	WP7 - Large-scale R&I initiative beyond the CSA												
	T7.1 - Develop scenarios & instruments for a SUNER-C LSRI						D7.1/MS2						
	T7.2 - Engagement of the private sector in the LSRI								D7.2				
	T7.3 - Governance structure												D7.3
	T7.4 - Funding mechanisms												D7.3
8	WP8 - Project Management and Coordination												
	T8.1 - Monitoring of the overall project progress					D8.1			D8.5				D8.7
	T8.2 - Communication with the European Commission								D8.2				D8.3
	T8.3 - Quality and Impact Assurance												
	T8.4 - Data management plan					D8.4			D8.6				D8.8

All deliverables and milestones were fully achieved within RP1. Most deliverables were on schedule, but the following deliverables and milestones were delayed within RP1, with agreement of the project officer:

- **D1.1 (“Shared vision” - LU) and related MS1 (“Shared SUNER-C vision” - LU)**

This deliverable was delayed from M12 to M16 because it took more time than initially expected to include all contributions to the vision, including in particular that of societal stakeholders. MS1 was delayed correspondingly from M12 to M17 to provide time to present the shared vision to stakeholders for endorsement at our yearly general assembly.

- **D5.3 (“Website development including intranet and education platforms” - ICIQ)**

This deliverable was submitted on time at M5 and reopened at the request of the project officer to operate a few modifications on the website, so as to clarify the differences between SUNER-C and SUNERGY content more clearly. The second and final version of this deliverable was submitted on M9.

- **D7.1 (“Scenarios and instruments for a LSRI” - CEA) and related MS2 (“Scenarios for a SUNER-C LSRI in HE” - CEA)**

D7.1 and the corresponding MS2 were postponed from M15 to M16. This was due to constraining and unpredictable agendas at the various committees in charge of partnerships at the EC, as the partners in charge of this deliverable were involved in urgent discussions regarding a potential EU co-programmed partnership on solar fuels and chemicals at the time. The outcomes of these discussions are an integral part of D7.1 and MS2.

Below, an overview of objectives per WP and key activities towards these objectives is given. Later in this document, a detailed report for each WP is provided.

WP1 (Creation of an R&I community and eco-system) objectives: strengthen the SUNERGY community by building and structuring an all-inclusive, gender-balanced research and innovation community and eco-system with a shared vision on the affordable manufacturing of solar fuels and chemicals. In reporting period 1, the following activities were led to support this objective:

- Found consensus on the vision through a workshop – ‘solar energy closely coupled to chemistry and direct air capture’
- Drafted a vision document involving over 20 authors, with enhanced focus on a societal perspective, which was presented during our yearly general assembly, gathering feedback for ongoing revisions
- Defined key target groups and competencies for mapping the innovation eco-system
- Developed a questionnaire for stakeholders and engaged the SUNER-C community
- Established connections with international programs, such as the Mission Innovation Collaborate Platform “Sunlight-to-X”, the International Energy Agency (IEA) and UK Solar Chemicals Network

WP2 (Ongoing research activities in the EU) objectives are to map the landscape of R&D projects relevant to SUNERGY; monitor project progress, foster synergies, promote interactions between EU and national projects ; standardize protocols and define common KPIs for effective technology benchmarking. The following activities were led to support this objective in RP1:

- Mapped EU projects on solar fuels, conducted workshops, and created a database.
- Identified KPIs, ongoing discussions with portfolio projects.
- Organized workshops to foster synergies among projects.
- Initiated discussions on standardization during workshops.

WP3 (Long-term technological roadmap) objectives are to establish a long-term technological roadmap based on shared vision and community input, provide a blueprint for its implementation and propose topics for Horizon Europe Work Programmes. The following activities were led to support this objective in RP1:

- Organized a roadmapping workshop at the start of the project (M1) to kick-start the process of preparing a roadmap and create dedicated working groups
- Developed a living document for SUNERGY roadmap with input from diverse stakeholders.
- Contributed to the Clean Energy Technology Observatory report.
- Identified tentative topics aligned with SUNERGY priorities for consideration in draft work programs.

WP4 (Innovation and exploitation) objectives are to develop a plan for exploitation of the SUNERGY technology R&I portfolio; to formulate recommendations for de-risking industrial implementation of said technologies, while promoting societal dialogue around solar fuels and chemicals; and to create a European innovation strategy for the LSRI. The following activities were led to support this objective in RP1:

- Developed and submitted the SUNER-C Exploitation and Innovation Plan, focusing on broad dissemination to stakeholders. Ongoing updates are planned based on project evolution and stakeholder feedback.
- Initiatives started at M13 for de-risking industrial implementation and ensuring societal acceptance. Stakeholder engagement activities, including interviews and a planned joint workshop with WP7, are in progress.

WP5 (Dissemination, communication and education) objectives are to communicate and disseminate project activities, progress, and results; organize events; engage stakeholders in the innovation ecosystem and prepare education materials to promote interest in solar fuels and chemicals

- Successfully developed and implemented the Communication and Dissemination plan, including a website, social media presence, and educational platform and materials.
- Organized all SUNER-C consortium meetings, general assemblies and workshops as well as national and regional stakeholder meetings.

WP6 (Socio-technical and cross-cutting aspects) objectives are the identification of key cross-cutting socio-technical challenges; engagement of industry, academia, governmental and NGO stakeholders; and implementation of a strategy to address the identified challenges during the CSA and beyond.

- Completed data gathering and analysis for cross-cutting socio-technical challenges
- Developed a "Conversation Tool" to facilitate discussion of societal issues between stakeholders
- Organized a stakeholder dialogue session to discuss implications for transition pathways, facilitating interaction between SUNER-C academic, industry and policy stakeholders with NGOs

WP7 (Large-scale R&I initiative beyond the CSA) objectives are to identify opportunities for a LSRI, engage the private sector in this LSRI and prepare for implementation by proposing a governance structure, stakeholders, terms of reference and funding mechanisms.

- Explored scenarios and instruments. Delivered a strategy, prioritizing scenarios and identifying HE instruments for an LSRI
- Ongoing campaign for letters of support from industrial stakeholders with dozens of industrial endorsements
- Began planning a workshop at M24 to engage industrial stakeholders in partnership development

WP8 (Project management and coordination) objectives are to ensure the CSA operates efficiently, achieving its objectives fully and punctually; implement risk management plans; establish a quality and impact assurance team; prepare data management plans; and manage communication with the European Commission.

- Established a quality impact and assurance expert team led by partner LU, which assesses the impact and quality of SUNER-C deliverables

- Ensured the on-time delivery of all deliverable in RP1, or agreed on delays with the EC
- Prepared and delivered a risk management report and data management plan for the CSA
- After a partner withdrew from the consortium, prepared and executed an amendment to the grant agreement for reattribution of resources
- Collated and verified financial statements from partners and prepared this interim progress report

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1.2 Explanation of the work carried out per WP

1.2.1 Work Package 1: Creation of an R&I community and eco-system

Objectives: The objectives of work package 1 (WP1) are building and structuring an all-inclusive, gender-balanced research and innovation community and eco-system with a shared vision on the affordable manufacturing of solar fuels and chemicals for the decoupling of economic growth from the use of natural resources.

Task 1.1 (M1-M12) - Shared vision (lead: LU, participants: UW, ENGIE-LAB, ENGIE, UU, CEA, ERIC, GU, ICIQ, SE, DECH, Fraunhofer, UTU, UppU, HIPC, with input from all partners)

As a first step towards building a shared vision, and to provide a starting point for the roadmap (WP3), an open vision-building workshop has been organized in conjunction with the 2nd consortium meeting in February 2023. Next to the vision workshop that took place in the morning, a breakout session for Task 1.1 was held in the afternoon, with the contributions of LURIS. During the breakout session, a consensus on the content and continued work on the shared vision of the SUNER-C consortium was reached by the stakeholders attending the session. An end goal was set as '*solar energy closely coupled to chemistry and direct air capture*'.

The outcomes of the vision workshop and the breakout session have been used as an input for the shared vision internal report (D1.1). The afternoon breakout session results have been condensed into text, forming the framework of the document. The shared vision has been agreed to have a societal perspective in the focus. Therefore, communications took place for the aim of keeping the societal perspective central.

Two series of online meetings have been arranged with the committed authors for the vision document, among the partners. These meetings have also been another opportunity for further sharing new comments and making fine adjustments on the shared vision, without deviating from the main goal, that was agreed upon during the vision workshop. One of the highlights of these meetings has been the lack of a competitive business model for direct conversion of solar energy into chemicals. The internal vision report has then been written by the contribution of over 20 authors.

The initial draft of the vision document has been sent to the partners for reviewing. It has also been presented during the general assembly, combined with the 3rd consortium meeting in October 2023. During the general assembly meeting, many comments and suggestions were made by the participants. In particular, there were suggestions to de-emphasize the decentralization of fuel production within the shared vision. The integration of the societal perspective in the vision document was further discussed.

Currently, the vision document is being revised based on the feedback received during the general assembly and the 3rd consortium meeting. The main focus at the moment is the integration of the societal perspective, and defining the balance between centralized, decentralized / indirect, and direct technological approaches within the SUNER-C frames. Further revisions, mainly on the chapters 'The social challenge of using more solar energy' and 'Efficiency / distributed / cost' of the document, will take place.

Throughout the preparation process, the vision document has always been managed and kept in the WP1 SharePoint folder, open for contributions and comments from the authors. The document is still accessible for comments and suggestions by the authors. Furthermore, a dedicated webpage has been prepared under the SUNER-C website, for publishing the shared vision document as a

milestone, currently targeting the supporters next to the partners. An up-to-date version of the document can be reached through the link provided on the webpage.

After the revisions, the shared vision document will lead to a scientific publication and further adjustments will take place in that direction.

Task 1.2 (M1-M36) - Community mapping (lead: ICIQ, co-lead: CVE, participants: UU, CEA, GU, LU, Fraunhofer, UppU, HIPC, with input from all partners)

The objective of this task is to map stakeholders and initiatives across the EU and at national/local levels and engage them to actively participate in SUNER-C activities and beyond. The main work in this task has been first to describe the key target groups to be mapped for the innovation eco-system and the capacities to be mapped.

For the definition of the key target groups, the same definition already provided in the SUNER-C proposal was followed, just including minor updates.

For the definition of the competences, after several meetings between the task leaders and the WP leaders, it was decided to start with the competences already described in the SUNRISE Blueprint document,¹ which already included descriptive elements to implement a European large-scale research and cooperation working on securing the supply side of the circular economy with renewable fuel and chemicals. The ICIQ team elaborated a first draft with an update of the listed competences and descriptions that was further complemented with feedback from UppU and CVE. It was agreed to divide the competences into three layers: technical-related competences, infrastructure-related competences, and cross-cutting ones. So, to make it easier for the final online mapping users to filter and identify active actors in specific areas.

Finally, the three layers of competences diagram was presented in front of the SUNER-C management board and full consortium, in the last Consortium Meeting held in Brussels in October 2023. Small changes and additions were added according to the feedback received.

In parallel, the ICIQ team, responsible for the website, has had several meetings with the website suppliers to incorporate a filterable mapping database to the SUNER-C web. A first version is publicly available from the end of November 2023.

For populating the mapping database, ICIQ and CVE teams have been supported by the business developer at LU, contributing to the preparation of a simple questionnaire including dropdown questions to select the kind of participant and their competences. Additionally, the questionnaire includes the identification of a contact person from each institution and the identification of gender aspects to provide measurements of gender balance as included in the proposal. These latest data will not be made public, just kept for statistical analysis.

The questionnaire also includes the option of sending feedback. This will be important, as the current definition of target groups and competences, although having been previously assessed within SUNER-C consortium, might be susceptible of further changes throughout the project's life.

The business developer at LU, Serkan Esiner, is currently in charge of sending the questionnaire to the SUNER-C partners, the International Advisory Board and to all the SUNER-C / SUNERGY supporters, to get data for the public mapping database.

In the second half of the action additional identified actors will also be contacted. This exercise will serve also to disseminate the SUNER-C project and the current community, seeking to enlarge it getting new supporters.

Task 1.3. (M13-M36) - Structuring the stakeholder landscape into an eco-system (lead: UppU, co-lead: LU)

Subtask 1.3.1 - Forming the connections and dependencies between stakeholders (lead: CVE, participants: UppU, LU, CEA, ERIC, ICIQ, SE, DECH, HIPC with input from all partners): The

¹ Leif Hammarström, Ann Magnuson, Huub de Groot, Harald Kerp, Frédéric Chandezon et al. (2020). Deliverable 1.3. Blueprint (v2.1). Zenodo. <https://doi.org/10.5281/zenodo.3989517>

aim of this task is to define and shape stakeholders' priorities and their potential contribution - with timings - to cost-effective, economically efficient value chains to align with the roadmap (T3.1). A formative eco-system workshop, co-organized with T5.2, will be held in 2024 (initially planned for M18 but postponed to M24 due to logistic reasons).

National and regional stakeholder meetings will be organized by the partners to consolidate the connections and dependencies across EU countries during Months 1-18. During 2023, national and regional stakeholder workshops have thus been held in France (March 28), Czech Republic (September 20), and Sweden (October 24-26).

Subtask 1.3.2 - International cooperation (lead: UppU, participants: CEA, ERIC, LU, SE, Fraunhofer, CVE, HIPC, EERA): This task will identify and establish links with other relevant international programmes and initiatives in particular with the International Energy Agency (IEA) and Mission Innovation.

During M1-18, SUNER-C has established a connection and ongoing discussions with the Mission Innovation Collaborate Platform "Sunlight-to-X" (formerly known as Innovation Challenge 5 – Converting Sunlight), which was approved as an official MI Platform in the spring of 2023. Representatives from SUNER-C (Ann Magnuson, UppU; Frédéric Chandezon, CEA) have thus participated in all core group discussion meetings of the MI platform. A formative workshop for Sunlight-to-X will be held in Ventura in February 2024, with several invitees from SUNER-C. At this event, the vision, agenda and mode of global collaboration for Sunlight-to-X will be staked out in dialogue with SUNER-C.

A joint stakeholder workshop in collaboration with the International Energy Agency is planned for 2024.

1.2.2 Work Package 2: Ongoing research activities in the EU

Objectives: The main objectives of WP2 are (i) Map the landscape of R&D EU and major national/international projects contributing to the advancement of the priorities as identified in the vision and SUNERGY SRIA; (ii) Identify their KPIs and their contribution to SUNER-C' KPIs; (iii) monitor projects' progress in relation to the timescale of SUNER-C roadmap; (iv) foster synergies between projects to accelerate the realisation of common objectives; (v) promote multisectoral project relations, in particular with digitalisation area; (vi) Identify and foster interactions between EU projects and those at the national level (large national projects); and (vii) Identify standardisation protocols and define common reliable KPIs to promote comparison between results and allow more effective data sharing. These three objectives are addressed through four tasks.

Task 2.1 (M1-M36): Project portfolio (lead: ERIC, participants: GU, LU, ICIQ, UTU, HIPC, CVE, TOTAL and AD for digitalisation projects)

T2.1 aims to map the relevant EU projects and selected national/international projects during the CSA and engage them to participate in SUNER-C activities, build synergies and share actions to support CSA priorities.

This task was the main focus of the reporting period because the other tasks were related to this one. The deliverable 2.1 (submitted) reports the status of the activities made. The activities detailed in the deliverable were the following:

1. Definition of the strategy to map the EU landscape on solar fuels (**SFs**), with the initial collection of data
2. Discuss this strategy during the SUNER-C meeting in Brussels on 15-16th Feb. 2023 in a dedicated breakout session; obtain feedback from the audience on possible improvements and other projects to include
3. Analysis of the EIC project portfolios to identify (running) projects closely related to SUNER-C. In particular, the following EIC thematic portfolios were analysed (i) renewable hydrogen, (ii) energy storage, (iii) solar conversion technologies and (iv) energy harvesting and conversion.

4. Organisation in collaboration with EIC of an online workshop (June 21, 2022) to discuss selected projects in the area. Projects which agreed to participate were the following: FuturoLEAF, NANO-EH, Pulse-Com, NATHALIE, Boostcrop, Artibled, Light-Cap, A-LEAF.
5. Analysis of the EU landscape on solar fuels indicates the general financial support given to this area. Analyse selected EU solar fuel projects to identify trends, directions, and gaps.
6. Based on these activities, the first project portfolio was created by scouting the projects on SFs.
7. Organisation of a WP2 workshop (online) on the portfolio of projects on SFs. Fifteen projects participated in the event. The aspects discussed were (i) how to maximise the path to SFs, (ii) how to maximise the impact.
8. Creation of an updated list of projects on SFs for the WP2 project portfolio, with a specific focus on SUNER-C/SUNERGY supported HE calls and projects, but not exclusively limited to these calls (reported in D2.1).
9. Organisation of a second WP2 workshop (19 participants) on the portfolio of projects on SFs the morning before the 18M meeting of SUNER-C (Brussels, Oct. 10th 2023). Questions discussed during the meeting were (i) What would be the specific contribution, in terms of R&D&I, that your project could bring to the general objectives? (ii) Would you provide information about the project's Key Performance Indicators (KPIs)? This information can be handled confidentially for the EU SUNER-C deliverables report. (iii) Is there specific (non-confidential) knowledge that your project could share with others to reach the above objectives? Please differentiate in terms of materials, electrodes, reactors, etc. (iv) Can you identify R&D areas where accelerating knowledge sharing would be necessary for increasing the impact of your project? (v) There are activities (not R&D, such as dissemination, communication, societal impact, etc.) where you believe creating a portfolio of projects could increase the overall impact? (vi) One of the weaknesses in the general area of solar fuels and related technologies is a lack of common metrics, defined testing procedures, protocols, and platforms for comparative assessment of the results. Do you believe activities in this direction are necessary to improve the impact, and can you indicate a priority list or specific actions necessary?
10. Creation of a large database of EU projects. Details are in the Annex 1. It is available for use inside the project, while external access will be made when solved aspects of confidentiality.

Task 2.2 (M1-M36): KPIs and project portfolio monitoring (lead: UTU, participants: UU, CEA, ERIC, GU, LU, DECH, ENGIE, and AD for digitalisation projects)

T2.2 aims to identify KPIs to monitor the contribution of projects from the portfolio to the CSA's vision, roadmap and timeline and quantify the added value of a coordinated approach compared to the current practice with a portfolio of non-coordinated projects; identify gaps; promote multisectoral project relations in particular with digitalisation area. After establishing a more trusted relationship with the portfolio projects, especially the new ones, discussions on KPIs are in progress.

These activities were realised in parallel to Task 2.1, and the activities are outlined above.

Task 2.3 (M7-M36): Fostering project synergies (lead: ERIC, participants: UU, CEA, ICIQ, DECH, UTU, SYN, AM, TOTAL)

T2.3 will organise activities/meetings to foster synergies between the projects, identify specific actions and shared objectives to accelerate projects' technological progress, and facilitate the realisation of common objectives.

These activities were realised in parallel to Task 2.1, and the activities are outlined above.

Task 2.4 (M13-M36): Standardisation of protocols (lead: IMDEA, participants: CEA, ERIC, GU, LU, ICIQ, DECH, UTU, AD, IMEC, ENGIE): This task is expected to have main activities in the second part of the project.

As commented above, an initial discussion already started on these aspects during the second WP2 workshop.

In terms of deliverables for WP2:

1. D2.1 - List of projects in the portfolio at mid-term (R, PU, M18) (ERIC). The deliverable has been achieved as planned and submitted along with Annex 1 related to the database of the projects.

Further deliverables are expected at M30 and M36.

2. D2.2 - KPIs and actions realised to foster synergies between projects of the portfolio (R, PU, M30) (UTU)
3. D2.3 - Standardised protocols and KPIs for comparing results and experiments (R, PU, M36) (IMDEA)

No milestones were planned for WP2.

1.2.3 Work Package 3: Long-term technological roadmap

Objectives: (1) Establish the long-term technological roadmap of the large-scale R&I initiative based on the shared vision and the community ecosystem (WP1). Dedicated groups of experts will seek cross-disciplinary solutions to eliminating the white spots identified in the technological portfolio; (2) Provide the blueprint for the implementation of SUNER-C technologies in the short, medium and long term based on the roadmap.

Task 3.1 (M1-M36) - Technological Roadmap (*lead: ENGIE-Lab, co-leads: UW, IMEC, participants: all partners*)

In this task, we focused on the establishment of the key elements of the SUNERGY roadmapping process:

1. **The SUNERGY roadmap is conceived as a living document.** It will be updated over the next three years of the SUNER-C CSA and will help to grow, integrate and align the community around the topic of solar fuels and chemicals.
2. The overarching goal of the SUNERGY initiative is to **group all the actors of the innovation ecosystem** of solar fuels and chemicals. It is designed as an **inclusive** network and counts on the expertise of stakeholders from **diverse backgrounds**. The SUNER-C CSA allows its consortium partners to play an active role in the SUNERGY Roadmapping process; but: the roadmapping is open for any participation, also from outside the consortium. Within the SUNERGY Roadmapping, the expert group is organized into working group leaders and participants to dedicated working groups. Working groups are led by a team of experts, in the best case a mix of leading academic and industry/RTO representatives to access both front-end knowledge and industrial applicability. All the working groups are open for the broadest participation of SUNERGY stakeholders.
3. **A first draft of the roadmap has been elaborated by SUNERGY's Strategic R&I agenda lead team.** The first draft of the roadmap draft facilitates the engagement of other stakeholders. It will be widely published in December 2023 and will be open for review by a broad stakeholder community. The first draft of the roadmap is based on the analysis of existing work: the SUNRISE technological roadmap, Energy-X's Research Needs, SUNERGY's Strategic R&I Agenda and Mission Innovation's Challenge 5 roadmap. The first draft of the roadmap has been provided and further developed by a broad community during SUNERGY's first roadmapping workshop (14-15 June 2022, Brussels). This workshop hosted over 140 participants from industry, academia and policy. It comprised high-level talks of leading experts to build a common ground and active work and discussions in dedicated working groups. Next to five technical working groups (Electrochemical conversion, Thermochemical conversion, Photosynthetic devices, Biological conversion and Sustainable CO₂ capture), social acceptability and the importance of future business models have been discussed. Before the first Roadmapping Workshop mentioned above, SUNERGY already started to scout for needs in industry and policy by conducting interviews with key stakeholders. This helped to optimally shape the

workshop content and structure. Moreover, it allowed to develop tailor-made output for the participating organization, increasing the chances for concrete implementation.

- 4. Roadmapping focus:** In the technological roadmap we will focus on the development of technological milestones, bringing us from the state-of-the-art to the vision, while we base our analysis on existing scenarios. At present, the state-of-the-art is being determined within the SUNERGY technological working groups (2nd Biological conversion workshop took place on 14 November 2023; other workshops will follow in the near future). The final SUNERGY Roadmap will be aligned to the actual needs of industry, policy and society.

Other Task 3.1 activities in 2023: The roadmapping expert team provided concrete input into the [Clean Energy Technology Observatory](#) (CETO) report. CETO is a common initiative between the JRC, implementing the observatory, DG RTD, and DG ENER. The observatory aims at monitoring EU research and innovation activities on the clean energy technologies needed to achieve the European Green Deal's objectives. The specific 2023 version of the CETO report that WP3 roadmapping experts contributed to is available under the following link:

https://publications.jrc.ec.europa.eu/repository/bitstream/JRC135361/JRC135361_2023.5109_KJN_A31700ENN.pdf

Task 3.2 (M24-M36) - Blueprint. (lead: LU, co-lead: UW, UppU, participants: all partners) is scheduled to start at M24.

Task 3.3 (M1-M36) - Establishing topics for Horizon Europe future Work Programmes (lead: CEA, participants: all partners). Task 3.3 aims at proposing topics for Horizon Europe Work Programmes (WPs) based on SUNERGY's SRIA and SUNER-C's roadmap. At the time of writing this report, the WPs 2025-2027 are under preparation with a focus on the WP 2025. In the frame of a dedicated working advocacy group, several tentative topics in line with SUNERGY/SUNER-C's priorities were identified for Cluster 5, namely:

- Coordination of European community and ecosystem of solar fuels and chemicals (CSA)
- Advanced artificial photosynthesis concepts for the production of synthetic renewable fuels (RIA)
- Synthesis of solar ammonia as a fuel for maritime transport (RIA)
- Next generation of solar thermochemical fuels (IA)
- Demonstration of a photo-electro-catalytic system for fuels production from carbon dioxide and water (IA)

Those tentative topics will be forwarded to national representatives in the Cluster Strategic Programme Committee of some member states, for consideration to be included in the draft work programmes. Next steps will include follow-up of the different drafts of the WPs and proposing amendments to those topics (if selected) and others of interest to the SUNERGY/SUNER-C community and scope. In addition, in Cluster 4, as solar chemicals are part of the Processes4Planet (P4P) European partnership scope and SRIA, SUNER-C experts provide some suggestions to the topics emerging from P4P in the draft WPs of Cluster 4.

1.2.4 Work Package 4: Innovation and exploitation

The central **objectives** related to WP4 are:

1. Develop a plan for the exploitation of SUNER-C's results
2. Elaborate recommendations for de-risking industrial implementation and supporting societal acceptance of solar fuels and chemicals
3. Develop a European Innovation Strategy for the LSRI to support industrial uptake of solar fuels and chemicals

These objectives are addressed in three dedicated tasks:

- Task 4.1 Exploitation and innovation plan (M7-M36)
- Task 4.2 Framework development for de-risking industrial implementation and supporting societal acceptance of solar fuels and chemicals (M13-M36)
- Task 4.3 European innovation strategy for the LSRI (M19-M36)

Task 4.1 (M7-M36) – Exploitation and innovation plan (lead SYN, participants: UU, HIPC, COV, CVE, AVT, NEXT, UB, AM, VIC, BBL, SOLVAY, TEOTB)

WP4 started at M7. The activities in WP4 in the first Reporting Period were focused on T4.1 (led by SYNEST) and on the development of the SUNER-C Exploitation and Innovation Plan, with a corresponding deliverable in M12. That report was submitted and represents the first version of the SUNER-C Exploitation and Innovation Plan. The main objective of this plan is to ensure that the project's results and outputs can be widely disseminated to the designated and appropriate target groups (research community, EU and member states policy-makers, industry and innovative actors of the ecosystem, the civic society and citizens in general and other stakeholders including European Research Technology Platforms, Infrastructures and similar Initiatives).

This communication should take place at appropriate times throughout the lifetime of the project and specifically at key milestones. It is also designed so that all the key stakeholders, including those that can contribute to the development, evaluation and benefit from SUNER-C outputs can be identified, reached and encouraged to participate. The report D4.1 contains a list of identified target groups to be considered in the SUNER-C communication strategy and suggests a number of specific activities, such as webinars and workshops, for communicating SUNER-C findings to the community.

During the duration of SUNER-C, this Exploitation and Innovation Plan will be a dynamic document that will be updated and adapted depending on the progress and evolution of the project and incorporating the feedback of the community and project office.

Task 4.2 (M13-M36) - Framework development for de-risking industrial implementation and supporting societal acceptance of solar fuels and chemicals (lead Fraunhofer, participants: UU, COV, AD, AVT, NEXT, AM, TEOTB, VIC, BBL, ENGIE, SOLVAY)

In addition to T4.1, T4.2 also started in the first Reporting Period, i.e. at M13. T4.2 is led by Fraunhofer and focuses on the development of a framework for de-risking the industrial implementation of new technologies related to solar fuels and chemicals. In the context of de-risking, there is a particular focus on ensuring the societal acceptance of such technologies. A central element of T4.2 is the exchange with relevant stakeholders (from industrial over scientific to NGO representatives). For that purpose, a comprehensive list of stakeholders (stakeholder categories and specific companies, institutions, etc.) has been compiled. Ongoing activities aim for the development of interview guidelines and specific questions for the planned stakeholder interviews. In this sense, it is planned to hold a joint stakeholder workshop in collaboration with WP7 in summer 2024.

Task 4.3 (M19-M36) - European innovation strategy for the LSRI (lead SE, participants: UU, CEA, COV, AD, AVT, NEXT, AM, VIC, SOLVAY, TEOTB) is set to begin at M19.

1.2.5 Work Package 5: Dissemination, communication and education

Progress towards the objectives

Since the start of the project, the WP5 activities have been focused on:

- ✓ communicating the project's activities
- ✓ organizing events, consortium meetings, assemblies and workshops
- ✓ disseminating the project's progress and results
- ✓ actively engaging societal stakeholders in the innovation eco-system and its activities
- ✓ preparing education materials and outreach activities to raise interest in solar fuels and chemicals

These actions are essential to contribute to the achievement of SUNER-C general objectives, promote the project's vision for supporters' engagement, and increase the impact of the project and its potential to be the seed of future steps.

In order to do so, the first eighteen months have been dedicated to laying the foundation of WP5 activities by developing the necessary tools and channels, involving the consortium in all initiatives and events, and providing them with the material and guidance to exploit synergies and act as multipliers to ensure maximum visibility and engagement.

During the first eighteen months of the project, the WP5 co-leaders (CVE and ICIQ), in cooperation with the entire consortium:

- i) developed a Communication and Dissemination plan and strategy;
- ii) designed the visual identity of the project;
- iii) created presentations and material to be used by the consortium during conferences and events;
- iv) developed and kept updated the project website and social media channels as the main source of information and engagement for all target stakeholders;
- v) organised all the project meetings like Consortium meetings, yearly General Assembly, specific WP workshops, and National/Regional events; and
- vi) prepared an open platform with available educational material under the SUNER-C website.

Task 5.1 (M1-M18) - Development of the Communication and Dissemination (C&D) plan and strategy (lead: CVE, co-lead: ICIQ, participants: all WP (co)leaders)

The Communication and Dissemination (C&D) plan and strategy (D5.2) was developed by M4 to strategically guide all communication actions and dissemination efforts during the entire course of the project and be carried out by the project consortium to:

- ✓ effectively manage SUNER-C's visibility;
- ✓ raise awareness of SUNER-C activities;
- ✓ engage with stakeholders, share SUNER-C's project results; and
- ✓ link them to the preparation and implementation of a LSRI (Large-Scale Research and Innovation Initiative).

Based on a well-designed communication strategy, each project partner must promote our activities and results by providing targeted information to multiple targeted audiences strategically and effectively using the right media channels from the start of the project until the end.

Through the dissemination strategy, all project partners need to disclose the results achieved in the SUNER-C project to the different targeted audiences to maximize the results' impact and allow other researchers to go a step forward.

The C&D plan and strategy was updated on M18 (D5.6). As SUNER-C progresses, it will provide more details for activities planned in the following years, like:

- ✓ Updated event planning throughout the project;
- ✓ Updated KPIs;
- ✓ Communication kit to be added;
- ✓ Weekly editorial plan regarding our website and SM posts;
- ✓ Supporting and promoting regional and national events; and
- ✓ Co-organisation and participation in different external events.

Task 5.2 (M1-M36) - Organization of project meetings (lead: CVE, co-lead: ICIQ, participants: all WP (co)leaders, EERA)

During the SUNER-C project, and specifically by M18, WP5 has organised the following events:

- monthly executive board meetings (coordinators + WP leaders online),
- 3 bi-annual consortium meetings,
- 1 yearly general assembly,
- meetings with the International Advisory Board (coupled with consortium meetings), and

- meetings specific to the activities of the WPs:
 - WP1: Vision-building workshop (year 1)
 - WP3: Technological roadmap workshop (year 2)
 - WP6: Stakeholder dialogue sessions (year 2)

In SUNER-C events, the project partners have been active in the role of speakers and moderators while the WP5 leaders coordinated the event agenda together with the project coordinators, supported the organisational aspects, and activated all promotional and communication actions. Such events are also occasions to build on common goals and different networks:

Date	Event	Organisers	Attendees
14-15/06/2022	Yearly General Assembly & Joint Roadmapping Workshop	SUNER-C, SUNERGY community, EIC, and DG RTD	120
27-28/09/2021	SUNER-C Kick-Off meeting (1 st Consortium Meeting)	SUNER-C	60
15-16/02/2023	SUNER-C Vision Workshop & 2nd Consortium Meeting	SUNER-C	60
10-11/10/2023	Yearly General Assembly, WP6 Stakeholder Dialogue Workshop, and 3rd Consortium Meeting	SUNER-C	100

Moreover, WP5 has been involved in the organisation of a thematic workshop to promote European projects on relevant topics identified in WP2 and foster cross-dissemination activities and information exchange: **SUNER-C: foster activities between projects in solar fuels (10 October 2023)**.

External events have also included 3 large national/regional meetings to promote the visibility of the initiative with policymakers, industrial stakeholders, the scientific community, national associations, and societal and other relevant stakeholders. These meetings have been co-organised in collaboration with relevant national associations or institutions:

Date	Event	Organisers	Attendees
28/03/2023	French National Meeting (Séminaire ANCRE-SUNER-C: comment promouvoir la filière des carburants et molécules de commodité alternatifs en France et en Europe?)	SUNER-C and the French National Alliance on Energy Research (ANCRE)	80
14-15/09/2023	Czech Regional Meeting (Transition pathway toward sustainable fossil-free fuels and base chemicals – a SUNERGY regional meeting)	SUNER-C, J. Heyrovský Institute of Physical Chemistry (Czech Academy of Sciences), and Association of Czech Chemical Industry	70
24-26/10/2023	Swedish National Meeting (Uppsala University Conference on Sunlight- and Power-to-X: Solar Fuels, Electro Fuels, Green Hydrogen, and CO2-Valorization)	SUNER-C and the Swedish Consortium for Artificial Photosynthesis	120

In addition to SUNER-C events, SUNER-C consortium partners have participated in several third-party conferences and events organised by other projects, platforms, or partners which also helped develop and strengthen collaboration with other stakeholders and initiatives:

Date	Event	Event organiser	Speakers/Participants
6-8/06/2022	19th Nordic Symposium on Catalysis	Finnish Catalysis Society	ERIC
10-11/11/2022	DECARB 2022 Conference	Czech Presidency of the Council of the European Union	CEA and UU
30/07/2022-02/08 2022	12th International Conference on Environmental Catalysis (ICEC2022)	Co-organised by Environmental Catalyst Division, Catalysis Society of Japan, Division of Materials and Manufacturing Science, Graduate School of Engineering, Osaka University, and Faculty of Environmental and Urban Engineering, Kansai University	ERIC
09/08/2022	Global forums. Frontier of chemical engineering	Organised online by Frontier of chemical engineering	ERIC
28/08/2022-02/09/2022	44th International Conference on Coordination Chemistry (ICCC)	Organised by the Inorganic Chemistry Division of the Italian Chemical Society,	ERIC
15-16/12/2022	AVOGADRO COLLOQUIA 2022	Co-organised by Società Chimica Italiana and Consiglio Nazionale delle Ricerche	ERIC

13/04/2023	Sustainable and low carbon fuels and chemicals – Time for take-off	CEA (SUNER-C Consortium partner)	ArcelorMittal CEA, CVE, HIPC, SIEMENS ENERGY
08/06/2023	Sustainable fuels: what role for Europe's energy mix?	A round table organized by SUNERGY community	CEA, CVE, ENGIE ERIC, ICIQ, UGent, UppU, and UW
10-11/06/2023	Festa de la Ciència of Barcelona	Barcelona City Hall	ICIQ
13-16/06/2023	GIC2023 and International Workshop "Catalysis for carbon neutrality and energy transition"	Organised by Università di Genova	ERIC
27/08/2023-01/09/2023	EuropaCat 2023 (SUNERGY/SUNER-C Session)	Co-organised by catalysis societies of the Czech Republic, Hungary, Poland, and Slovakia	ERIC, UGent, and UU
17-21/09/2023	14th European Congress of Chemical Engineering and 7th European Congress of Applied Biotechnology	Organised by DECHEMA (SUNER-C Consortium partner) in cooperation with the European Federation of Chemical Engineering (EFCE) and the European Society of Biochemical Engineering Sciences (ESBES).	DECHEMA and ERIC
18-21/09/2023	Symposium B - Advanced catalytic materials for (photo)electrochemical energy conversion of the European Material Research Society (eMRS) - Fall Meeting	Co-organised by eMRS with: Polish Materials Science Society, Institut of Physics PAN, Fondation Jean-Marie Lehn, MDPI nanomaterials, UNESCO Chair on Materials Sciences, MATTER, Łukasiewicz Institute of Microelectronics and Photonic, University of Technology in Warsaw	IMEC and UW
18-22/09/2023	Solar2Chem Conference: From Sunlight to Fuels – Uniting Science and Environmental Responsibility	Solar2Chem consortium (European MSCA-ITN project) led by Galway University and ICIQ (SUNER-C Consortium partner)	CEA, ICIQ, UppU
4-5/10/2023	Hydrogen Horizons Workshop	ANEMEL consortium (European project) and ICIQ (SUNER-C Consortium partner)	ICIQ
15-18/10/2023	4th International Symposium on Catalytic Science and Technology in Sustainable Energy and Environment (EECAT 2023)	Co-hosted by the Chinese Society for Particle Science, Beijing University of Technology and Tianjin University	ERIC
12-14/11/2023	1st International Conference on Materials for Energy Storage (ICMES 2023)	Co-organised by CRTSE, RSDT, and CMSI	ERIC

The WP5 co-leaders supported partners with the creation of a standard communication kit of media-related materials that can be used in various types of events (including a standard PowerPoint presentation and the design of roll-up banners, flyers A5, brochures, and a conference poster ready to be printed by the partners).

Task 5.3 (M1-M36) - Implementation of the Communication and Dissemination Plan (lead: ICIQ, co-lead: CVE, participants: all WP (co-)leaders with input from all partners)

This task covers all communication and dissemination activities taking place during the project and described in the communication and dissemination plan, including the development of the [SUNER-C visual identity \(D5.1\)](#), which was completed in M3.

The WP5 co-leaders coordinated the creation of the project's visual identity (re-branding of SUNER-C logo with the inclusion of SUNERGY community's name brand) and templates for the presentation of the project and its outcomes: a PPT layout and a Word template for working documents, such as meeting minutes, and reports, among others. The final versions of the logo and the templates were selected by the consortium and distributed among all partners.

- ❖ The development of the [SUNER-C website and social media accounts \(D5.3\)](#), which was completed in M5.

This task includes the configuration of the central communication tools: the website, the newsletter, and the social media channels as follows:

1. The re-design of the SUNERGY website as a “shop window” of the project (<https://www.sunergy-initiative.eu/>) and the creation of a special page for the SUNER-C Project (<https://www.sunergy-initiative.eu/suner-c>).
2. Planning and re-design of a bi-annual public newsletter to facilitate the dissemination of news and outcomes of the project and information related to the field of solar fuels and chemicals, funding opportunities and short opinion pieces in some of the Newsletters. Readers will be among SUNERGY's database and the new subscribers on the re-designed website. Below are the Newsletters/Alerts that have been distributed by the M18.
 - [22 December 2022](#) (Newsletter)

- [5 May 2023](#) (News Alert)
- [4 July 2023](#) (Newsletter)

3. The upgrade of SUNERGY's social media channels including banners with the SUNER-C's logo and the acknowledgment of the EU support: [Twitter](#), [LinkedIn](#), [Instagram](#), and [YouTube](#) accounts have been opened to raise visibility in the SUNER-C project, engage with the audience, and regularly communicate and disseminate information, news, events, and results of the project.

The consortium contributes to feeding the website and social media channels by sharing with the WP5 co-leaders the most recent news, progress, events, and activities. The WP5 co-leaders have the role of updating weekly the above-mentioned channels with the information provided by building an engaging editorial plan and ensuring a consistent communication style. KPIs for the communication channels can be found in D5.2.

- Targeted press releases and development of media-related materials.

The SUNER-C consortium ensures targeted dissemination of the project's outcomes and major progress and events among EU, national, and scientific media by WP5 to raise the visibility of the SUNER-C.

Drafting press releases and media appearances through participation in radio and newspaper interviews as well as in media news and podcasts is an important way to promote SUNER-C during the course of the project.

Task 5.4 (M1-M36) - Fostering education and create learning resources (lead: UB, participants: all universities and ICIQ, CVE, EERA, SYN)

Education is an important instrument within the CSA. For SUNER-C Consortium, it is of utter importance to stimulate future generations to learn about solar fuels and chemicals, if we want a pool of prepared workforces to achieve a climate-neutral Europe.

A first version of an Educational Platform (D5.4) is available since the end of November 2023 with some initial contents. Through the project's life it will be further populated with open learning materials and relevant courses, to act as an online platform where everyone (including primary and high-school students), PhD/master's Students and Scientific Professionals will find interesting resources.

Some examples of materials to be included are Books, Videos, Interviews, Podcasts, Scientific Papers, Hands-on Experiments, and Infographics. The content will be mainly in English but other European languages will also have representation. D5.4 was submitted at M18.

Task 5.5 (M19-M36): Communication and Dissemination Strategy and Plan for the LSRI: (lead: ICIQ, co-lead: CVE, participants: UU, CEA, UW) is set to begin at M19.

1.2.6 Work Package 6: Socio-technical and cross-cutting aspects

Work Package 6 has three **objectives**: (1) Identification of relevant, cross-cutting socio-technical challenges related to SUNER-C; (2) engagement of a network of stakeholders from industry, academia, governmental agencies and NGOs; (3) Implementation of a strategy to address the identified challenges during and beyond the CSA. These three objectives are addressed through three tasks.

Task 6.1 (M1-M24) - Identification of the most relevant cross-cutting socio-technical challenges related to SUNER-C (lead: GU, participants: UU, LU, UW, Fraunhofer, CVE, BBL)

Task 6.1. has as objective the identification of important cross-cutting socio-technical challenges related to the SUNER-C technology choices. Different activities for data gathering, data analysis, interpretation and presentation of results have been set up under this task. All of these activities were coordinated through regular meetings of the internal WP6 working group, consisting of Ghent University, Bond Beter Leefmilieu and Utrecht University.

A first phase of data gathering (M1-10) was mainly focused on input from actors that are involved in or closely related to SUNER-C. A second phase (M10-12) included actors not immediately involved

in SUNER-C. The main data sources for both phases were: 17 Interviews between October 2022 and May 2023; 3 workshops during SUNER-C consortium meetings (June 2022, October 2022, February 2023); around 25 observations during meetings and conferences; documents, reports and position papers from stakeholders. A preliminary version of the analysis was written down in a discussion paper for the SUNER-C Consortium meeting of 15-16 February 2023. During the meeting, the paper was presented in a plenary and a workshop and discussed with the audience. From March onwards, the paper was further developed, opened up to comments from the SUNER-C Board in November 2023, and finally published as Deliverable D6.1.

As part of the discussion paper and D6.1 we developed a so-called “conversation tool”. This tool will in fact be fully developed under Task 6.3, later in the project, but is for now available in an early, preliminary version. The tool, compiled of a number of guiding questions, is intended to inform and initiate a conversation about societal issues surrounding SUNER-C technologies. It helps to reflect on how to take these societal considerations into account when further developing and implementing the technology at hand, working on the vision, the roadmap, the connection with industry and other stakeholders, or the development of a future LSRI. By doing so it aims to reduce or avoid human and social costs of learning how to handle technology in society by including societal considerations in the development process, as opposed to learning through trial and error. To facilitate the use of the conversation tool by the WP leads and project partners, basic guidelines have been developed on how to use the tool and why it is important to include such conversations at an early stage of technological development. The tool was tested with representatives from ArcelorMittal and further refined. A second company will be approached to test it, collect feedback and further improve the tool.

An important aspect of the work under WP6 is the search for integration of societal concerns in different work packages (such as the vision under WP1, or the roadmap under WP3). On the 9th of June 2023 we presented to the Board a dedicated interaction mode between WP6 and the other WPs in order to improve the interaction and uptake of socio-technical aspects within the SUNER-C consortium. We started from the overall proposal where it is indicated that the project needs to overcome scientific, technological, organisational and socioeconomic challenges. We identified the deliverables in SUNER-C where the integration of socio-technical aspects is most essential. We also identified relevant deliverables where it is less needed. As last we proposed a working methodology to ensure the involvement of other WPs. This goes from agenda items on the board meetings, to the availability of documents but also to have dialogue moments between SPOCs from the different WPs.

Task 6.2 (M13-M30) - Stakeholder dialogue on implications for transition pathways (lead: UU, participants: GU, LU, Fraunhofer, CVE, EERA, BBL, with input from all partners):

The work for Task 6.2 started before the summer of 2023 and concentrated in a first phase on the organisation of a half-day workshop for the SUNER-C Consortium Meeting of 10-11 October 2023. The aim was to set up a dialogue process with stakeholders about the implications of cross-cutting issues for different transition pathways in the development of carbon-neutral fuels and chemicals. Concretely, it involved a conversation on October 11th 2023, in Brussels, between prominent SUNER-C representatives of research, industry and policy on the one side, and three NGOs on the other side. This stakeholder dialogue, based on the quadruple helix of actors involved in innovation processes, allowed the SUNER-C consortium partners to become more aware of the needs and concerns of these civil society stakeholders in an early stage of technology development, so their interests may be reflected in transition pathways to be taken. The format involved research, industry and policy representatives interviewing the three NGOs; questions and discussions with the audience (of +/- 90 people); and oral statements by SUNER-C representatives on how they could incorporate the societal issues raised by the NGOs in their ongoing SUNER-C activities. The results included discussions on what sectors and applications should (not) get access and for what reasons (e.g. scarcity of renewables and resource); the need for demand reduction; carbon sources; improving public debate; the domestic and global (south) impacts of import renewables and feedstocks; societal and environmental impacts; and when what scale of fuels should be achieved to scale-up in sync with demand forecasts. These results will feed back into WP1 and WP3.

Task 6.3. (M25-36) - Development of a strategy for integration of cross-cutting issues in an LSRI (lead: GU, participants: UU, LU, Fraunhofer, CVE, EERA, BBL)

This task will be developed later (M25) in the project, but an early result is the Conversation Tool that was presented in a preliminary version in the discussion paper and Deliverable 6.1 under Task 6.1. See above.

1.2.7 Work Package 7: Large-scale R&I initiative beyond the CSA

The aim of WP7 is to identify the opportunities for perpetuating the initiative through a large-scale R&I European initiative and to implement it so that this LSRI can be launched at the end of the SUNER-C CSA (June 2022 → May 2025). **WP7** thus aims at addressing the following point of the scope of the call **HORIZON-CL4-2021-RESILIENCE-01-16** under which SUNER-C was funded: “*Preparing a large-scale research and innovation initiative beyond the CSA, as a partnership or another instrument to be discussed and agreed upon with the Commission and the Member States and Associated countries*”. **WP7** (led by CEA, co-led by Utrecht University) includes four tasks and has three deliverables. At the time of writing this report, efforts have focused mainly on the first two tasks **T7.1** and **T7.2**. We thus give here a brief overview and update on the work done for those tasks.

Task 7.1 (M7-M15) - Develop scenarios and identify instruments for a SUNER-C LSRI (lead: CEA, co-lead: UU, participants: ERIC, GU, LU, ICIQ, SE, Fraunhofer, CAR, HIPC, UppU, CVE, EERA, TEOTB, ENGIE)

The work planned in T7.1 was achieved as planned and the related deliverable, D7.1, has been submitted. T7.1 aimed at exploring opportunities and building scenarios for a LSRI beyond the CSA including: (i) Existing instruments in Horizon Europe (HE) for LSRIs (partnerships, etc.); (ii) Analyze the landscape of LSRIs in the field of renewable energy sources and the complementarity and added value of a SUNER-C LSRI; (iii) Synergy and benefits that a SUNER-C LSRI could bring to existing national and regional programs.

It first involved the analysis of the European and national strategies, in particular in relation to the Green Deal and to the preparation of Horizon Europe's strategic plan for 2025-2027. Another key aspect was the analysis of the existing landscape of ongoing European R&I initiatives in order to identify possible gaps and how a proposal emerging from SUNER-C could fill this gap. This involved document analysis, monthly meetings of a dedicated working advocacy group, the organization of two online workshops involving all consortium partners to exchange on needs and strategies for this LSRI. All this was completed by several meetings with representatives of the European Commission and Member States to share these analyses and strategies, as well as the organisation of events, at European and national levels, to discuss these scenarios stakeholders involved in the field, not restricted to members of the SUNER-C consortium.

In brief, it turns that in the preferred scenario, the most relevant instrument identified is a co-programmed public-private partnership, a flexible instrument associating both public and private partners. Taking into account the landscape of existing and planned European partnerships, the topic of “**Sustainable fuels as energy carriers**” (SFs *i.e.* synthetic renewable fuels and advanced fuels) was identified as a gap in the current landscape of European partnerships. A co-programmed public-private partnership proposition on SFs in cluster 5 was thus prepared and submitted to the EC and MS in the frame of the discussions for the second wave of European partnerships of Horizon Europe to start in 2025. This proposal was endorsed by industrial and academic stakeholders from different EU countries and by several MS. The final list of new partnerships is currently being discussed between EC and MS delegates, the outcomes of which will be known end of 2023 or in early 2024. Of course, in case the “sustainable fuels as energy carriers” proposition is not selected in the final portfolio, alternative scenarios have been identified and proposed. All this is detailed in the Deliverable “**D7.1: Prioritized scenarios and related HE instruments for a SUNER-C LSRI**” which has been submitted.

Task 7.2 (M10-M30) - Engagement of the private sector in the LSRI (lead: CEA, participants: industrial partners + UU, CEA, ERIC, DECH, CVE, IMEC)

This Task is currently ongoing. As participation of the private sector is key in a tentative partnership, T7.2 aims at fostering the engagement of the European industrial stakeholders and industry driven networks and initiatives. This means organizing dedicated activities towards industrial stakeholders representing all the SUNER-C value chain for shaping the future partnership (governance, funding mechanisms, etc.): workshop with representatives of EC, MS and research community; campaign for letters of support from industrial stakeholders for the LSRI.

A campaign for letters of support from industrial stakeholders for the LSRI, entitled “Why Europe needs a public-private partnership on sustainable fuels – the industry view” was launched in March 2023. It gathers so far 27 endorsements for industrial partners from various EU countries (including TotalEnergies, Engie, Siemens Energy, Arcelor Mittal, Coverstro, Toyota, Vicat, Association of chemical industry of the Czech Republic, Cements Molins) and 40 from academic (universities, RTOs), networks and associations. The full list of supporters as well as the call can be accessed via [the following link](#). This campaign is still ongoing and dedicated actions are launched to reach new supporters, building on the work done in the frame of the task T1.2 “Community mapping”.

The second major aspect of this task is to organize a workshop to engage industrial stakeholders in the partnership. In more details, the main objective of the workshop is to inform and involve industrial players along the value chain in the construction of the partnership by tackling the various aspects, roadmap, governance, financing (particularly on the private financing part), links with public decision-makers (European Commission and Member States), links with the academic community, links with other national and European initiatives and communities (e.g. other relevant European partnerships). This is related to the deliverable **D7.2** “Workshop for industrial stakeholders about a LSRI”. The workshop will be organized around mid-2024 and would include the visit of an industrial site using technologies related to SUNER-C’s scope. This workshop will be co-organized together with WP4 and contributions of WPs 1, 3 and 6. The site identified is the university of Ghent with visit of the Arcelor Mittal Steelanol plant and the event will take place around mid-2024.

As a final point for this progress report, as tasks **T7.3** and **T7.4** are directly related to the implementation of the LSRI following the scenarios identified in Task **T7.1**. If the proposed solution, a co-programmed co-programmed public-private partnership on “sustainable fuels as energy carriers” is not retained by the EC and the MS, the work related to **T7.3** and **T7.4** might have to be re-evaluated.

1.2.8 Work Package 8: Project management and coordination

WP8 objectives are project management and coordination, ensuring the CSA achieves its objectives fully and punctually; implementation of a comprehensive risk management plan; establishing a quality and impact assurance team and procedure; prepare data management plans; and manage communication with the European Commission throughout the project's duration.

Task 8.1 (M1-M36) - Monitoring of overall project progress (lead: UU, co-lead: CEA with input from all WP (co-)leaders)

In Task 8.1, we successfully executed the monitoring of progress towards project objectives. Regular communication channels, including email, phone, video conferences, and in-person meetings, were established between the project manager, coordination team, WP (co-)leaders and all project partners, as well as with the project officers assigned to SUNER-C. This ensured a comprehensive and real-time monitoring process of the ongoing tasks in the project in RP1.

In line with the risks identified in the Description of Action part of the submitted proposal, a risk management report (RMR) was prepared, led by CEA, and constitutes D8.1. An updated version of this RMR based on the risks that either manifested, new risks identified or risks reassessed during RP1 was prepared and delivered at M18 as D8.7.

In preparation for the first interim progress report, due within 60 days of the end of reporting period 1 (M1-M18), the coordinator (UU) gathered formal progress updates from all other WPs to compile in the technical part of the progress report. The coordinator will ensure that the proper financial reporting of spending in SUNER-C from all partners is submitted in time in the Funding and Tenders platform and we list any deviations from the DOA budget later in this report (see Error! Reference source not found.). Together and once the periodic reporting is finalized, this will constitute D8.2

(this current document), to be delivered 10 days before the interim review meeting held on 26 January 2024.

Task 8.2 (M1-M36) - Communication with the European Commission (lead: UU, co-lead: CEA)

Within RP1, several deliverables had to be reported by a few months. Communication with the EC was ensured during the process, and the concerned deliverables are detailed at the beginning of this report under section 1.1 Objectives.

In Task 8.2, the project manager at UU communicated with the three successive project advisers appointed to SUNER-C at the European Commission, HaDEA, on all project reporting aspects. This included an amendment to the grant agreement following the request in August 2022 of partner NEXT #21 to withdraw from the project. The coordinator in WP8 facilitated communication within the consortium to find a way forward acceptable to all parties and worked with the EC to amend the grant agreement accordingly.

In brief, the budget of the departing partner was reassigned to the coordinator to use as subcontracting costs. In the same amendment, the duration of two work packages was extended by a few months to account for activities which started earlier than planned. A detailed explanation of the process goes beyond the scope of this report, and all relevant data can be found with the amendment documents (AMD-101058481-13), entered into force 18/12/2023.

Task 8.3 (M1-M36) - Quality & Impact Assurance (lead: LU, participants: all)

Task 8.3, led by LU, successfully established an internal Quality & Impact Assurance (Q&IA) Board. The Q&IA board consists of hand-picked, volunteer scientific experts from all SUNER-C partner organizations as well as outside, supporting organizations not directly involved in the day-to-day operations of SUNER-C. This board assisted the Project Coordinator (UU) and Co-Coordinator (CEA) in assessing the academic quality and usability of project deliverables and reports, and provided comments to the deliverables before submission to the EC. The collaborative effort of all partners in contributing to the QIA team played a crucial role in maintaining high-quality standards throughout RP1.

Task 8.4 (M1-M36): Data management plan (lead: AD, participants: UU)

In Task 8.4, led by AD, we prepared the Data Management Plan (DMP) that guides data handling in SUNER-C throughout the project's lifespan. Following the FAIR principles (Findable, Accessible, Interoperable, Reusable), AD prepared the DMP with the support of UU. The DMP gathers all needs in the SUNER-C project in terms of managing all data aimed at different purposes. For example, internally administrative and coordination tasks, data exchange with involved companies and stakeholders belonging to the domain of solar fuels and chemicals, all data gathered over the duration of this CSA, any created databases of technology or projects. This is in-line with the General Data Protection Regulation (GDPR) requirements and following the principle of FAIR research data. **This constituted D8.4 delivered at M6.** At M18, the data management plan was updated to include one more data source and storage with the creation of a searchable SUNER-C database of EU projects in the field of Solar Fuels and Chemicals. **This constituted D8.6 delivered at M18.** Further efforts in this task in RP2 will focus on preparing a DMP for the LSRI.

#§WRK-PLA-WP§# #@IMP-ACT-IA@#

1.3 Impact

Solar fuels and chemicals are essential for the EU to achieve a zero-emission society by 2050. However, current efforts to develop and implement innovations for solar fuels and chemicals are scattered across scientific and technological domains and industry sectors, often not sufficiently well connected to society, resulting in slow progress and suboptimal outcomes. A joint initiative is needed to build on expertise across the EU and coordinate efforts to accelerate innovation. Below, we explain progress towards the expected impacts of SUNER-C as specified in the DoA.

1.3.1 Impact towards main SUNER-C outcomes

In the SUNER-C Grant Agreement, under Description of Action, can be found the following list of expected impacts on the main SUNER-C outcomes. We state these expected impact again below, and under each impact, we summarize relevant progress and where applicable, expected steps in the second half of the SUNER-C project and beyond. SUNER-C supports the next step of the ongoing work of the SUNERGY community, to create the framework conditions to accelerating the development of new technologies on solar fuels and chemicals and the redesign of existing ones, as to foster their innovation and implementation, by building upon the established SUNERGY community of 300+ supporting organizations: 156 academic, 120 industrial, 14 government and societal, 28 network organizations; covering 18 EU countries;

The detailed activities linked to broadening the SUNERGY community are described above, especially in the detailed update of all WP5 activities as well as subtask 1.3.1 in WP1. Later in this report, under [section 1.3.2](#), we report on the metrics of engagement of the community and our projections for the second half of the SUNER-C project. Furthermore, the relevant metrics regarding events organized for the community can be found in deliverable **D5.6**, the updated SUNER-C communication and dissemination plan.

- A multidisciplinary & multi-sectoral approach, **complementary to other EU initiatives**;

SUNER-C partners and supporters involve academia, industry and R&I/technological/industrial network organizations as well as NGOs. Further NGOs as well as EU and national policy-makers have participated to SUNER-C events. SUNER-C builds upon the work of existing European/national initiatives and networks, particularly SUNERGY, a pan-European initiative involving stakeholders from industry, academia, RTOs, societal players and end-users, and EU and national networks and platforms. It works with policy/decision makers and international organisations and initiatives (e.g. Mission Innovation, International Energy Agency) to expand its global outreach.

*SUNER-C directly involves, collaborates with and builds on several existing platforms, including **CO₂ Value Europe** (industry-driven initiative) which represents the European Carbon Capture and Utilisation (CCU) community and the **European Energy Research Alliance**, both members of SUNERGY/SUNER-C). Other initiatives which are strongly related to SFs partnership proposition are the **Renewable and Low-Carbon Fuels Value Chain Industrial Alliance**, the **eFuel Alliance**, the **Alliance for Zero Emissions Aviation**, the **European Technology Innovation Platform (ETIP) Bioenergy** (on biofuels), the **European Waste-based & Advanced Biofuels Association** and **Bioenergy Europe**. There are already established contacts with part of those initiatives and others will be contacted shortly to discuss cooperation, as we work towards developing a SUNER-C LSRI.*

- **Working in close dialogue with EU institutions** (esp. EC – DG RTD, DG ENER, DG CLIMA, EIC – and EP – ITRE, ENVI Committees) **and national decision makers (incl. representatives in HE Strategic Programme Committee)**; building on two previous initiatives (ENERGY-X and SUNRISE FET-Flagship CSAs);

As part of the SUNRISE and ENERGY-X CSA projects (2019-2020), we set up an advocacy working group to elaborate an advocacy strategy and proposals to propose to the EC and the Member States relating to the themes of these two projects (which subsequently merged to form the SUNERGY initiative in 2020). This advocacy group brings together SUNERGY participants from several Member States. They act as nodes and entry points to bring the views of their national communities and to bring the proposals of the advocacy group to the representatives of their Member State in the Horizon Europe committees of interest in relation to the SUNERGY theme, such as pillar 2, clusters 4 and 5. The group meets monthly with an agenda that aims at implementing an advocacy strategy approved by the SUNER-C Executive Board.

The advocacy group was set up with members of the SUNERGY community who have a good knowledge of European processes, in particular the strategic planning processes of the Framework Programme and the preparation of Horizon Europe work programmes, and who are also familiar with the organisation for the representation of their member state. When this group was set up at the beginning of SUNERGY/SUNER-C, a proposal for its composition and decision-making process was submitted to the SUNERGY/SUNER-C executive board, which approved it. This advocacy

group has currently around twenty "permanent" members representing nine member states (BE, CZ, DE, ES, FI, FR, IT, PL, SE). The current SUNERGY and SUNER-C deputy coordinator serves as chair. Other members of the SUNERGY community may be invited depending on the agenda of the advocacy meeting or for specific actions. One of the future objectives would be to increase the number of member states represented in order to extend the reach of SUNERGY's messages to as many member states as possible.

In addition to representatives of MS at ad hoc committees (in particular cluster 5 of Pillar 2 of HE and the EU partnership Strategic Planning Committee), members of this advocacy group are in regular contact with European Commission representatives from various DGs, either at targeted events or for bilateral discussions. While there is regular contact with members of DG RTD, in particular the Clean Energy Transition unit within the Clean Planet directorate, we have also had contact with members of other DG RTD units as well as with members of other DGs, DGs ENER, MOVE and CLIMA, and the European Innovation Council. We have a network of contacts at the EC who are invited to certain SUNER-C events such as the general assemblies. In addition, as part of the preparation of a proposal for a co-programmed European partnership on sustainable fuels, we organised a round table in June 2023 to demonstrate the relevance of a partnership on this theme to representatives of the various DGs. As part of the process of presenting a candidate EU partnership on Solar Fuels proposed by the SUNERGY initiative and SUNER-C, the SUNER-C advocacy group was involved in the preparation of a presentation to a plenary session of the SPC meeting comprised of **representative of all EU MS as well as all relevant EC DGs**.

- An organizational structure up and running: **a board with academia and industry**; working groups on **policy and communications**; network with members involved at national level, **supporting the coordination of national and EU priorities; ongoing outreach activities/events**;

The governance structure of SUNER-C is detailed in the GA part B. During RP1, we have established an international advisory board (IAB) consisting of world-renowned academic and industrial experts. The current composition of the SUNER-C Executive and Advisory boards can be found on our website (<https://sunergy-initiative.eu/background/the-sunergy-initiative/>). As a working group on communications, among the tasks of the SUNER-C coordination office is the discussion of communication opportunities, participation to external events, outreach and education. The SUNER-C advocacy team, the functioning of which is explained in the previous point, serves as the main SUNER-C working group on policy, beyond the regular discussions on policy at SUNER-C consortium meetings and general assemblies.

- **SUNER-C roadmap** will build upon a preliminary **Strategic Research & Innovation Agenda (SRIA)**

The first version of the SUNER-C roadmap was prepared by the SUNER-C consortium within WP3, with participation from numerous stakeholders and co-authors. This constituted **D3.1** which was submitted in November 2023. This roadmap is built on the SUNERGY SRIA published in November 2022 and is to be updated by the end of the SUNER-C project, then every two years subsequently.

1.3.2 Impact metrics and progress towards completion

In the SUNER-C Grant Agreement, under Description of Action, can be found the following table which makes explicit the metrics of impact on the main SUNER-C outcomes. This table is reproduced below:

Ecosystem	From 300+ to 600+ stakeholders with equal shares of industrial / academic , ~10% societal stakeholders, and well-balanced in terms of country, stakeholder category, sectors, gender, with a searchable database	From 18 EU countries to all EU countries , and expanding global outreach (from current 14 non-EU countries) through collaboration with international organizations and initiatives	Cooperation with other initiatives & projects (national/EU/international): <ul style="list-style-type: none"> • All relevant EU partnerships, missions, platforms and major projects • At least 20 relevant major platforms in EU MS/AC • Connection with key international organizations and initiatives, and with one major initiative/platform in key non-EU countries
Roadmap	Covering period 2022-2050 and updated every two years . Endorsed by stakeholders of the ecosystem	Portfolio of indic. 50 projects , with ~2/3 EU projects and ~1/3 large national projects. Targeting >50 new topics on solar fuels & chemicals for HE Work Programmes up to 2027	Indicative estimate of mobilised funding & investments for the projects (RIAs, IAs): <ul style="list-style-type: none"> • Public funding: ~140M€/year over 7 years → ~1bn€ in total • Private investments: at least 1 bn€ over 7 years

Table 3 Expected scale of the project's contribution to the main outcomes.

For each metric of impact in the table above, we provide below the current state of progress towards the expected KPIs at the end of the SUNER-C project:

Ecosystem

❖ Stakeholders

Currently, the initiative counts with a large ecosystem formed by around **325 organizations**, including the current SUNER-C partners, members of its advisory board and the support organizations that have backed up the establishment of a renewable fuels and chemicals community in Europe by sending institutional support letters. Representatives of these organizations participate to the different actions promoted by SUNER-C, attending the events organized and contributing to different working groups as those set up to prepare the roadmap. At the end of this first reporting period the major sector is still formed by academia related institutions and research centers, but **industry actors have also shown real interest, representing 25%** of the involved stakeholders. **Societal, governmental and network stakeholders represent 13%**.

The strategy to get new support letters for the initiative, during this first period, has mainly been focused on the endorsement of proposals from consortia applying for funding. For proposals within the scope of sustainable fuels and chemicals, SUNERGY would prepare an endorsement letter for those proposals where half of the consortium members are supporters. This action has awakened interest from multiple consortia and has brought in more support letters for the initiative. However, one of the main efforts to get new supporters during this first period has been the issue of the Industry letter: "Why Europe needs a public-private partnership on sustainable fuels – the industry view". The letter advocates for the establishment of a new partnership in Europe and is endorsed by important European companies and industrial associations. Therefore, beyond giving visibility to the industry views on sustainable fuels, this exercise has also served to involve new industrial actors with the initiative (**12 new companies, 6 new academia/societal stakeholders**).

The organization of the different SUNER-C events has also got great impact in attracting new stakeholders to the project and the SUNERGY initiative.

The joint roadmapping workshop held in Brussels at the beginning of the project, June 2022, served to bring the community together after the COVID-19 restrictions. The event was co-organized with the European Innovation Council (EIC), closing ties with this European funding agency. This event was the first step towards creating working groups to draft the different parts of the roadmap,

attracting also new actors to the initiative, and establishing collaborations with different research and development projects.

Likewise, the year assembly held last October 2023 in Brussels, together with its linked WP2 and WP6 workshops and the SUNER-C consortium meeting, has also been a major milestone within this first period. It included several round tables for discussion, presentations from the EIC and Mission Innovation representatives and importantly, the Stakeholder Dialogue Workshop from the Work Package 6 that addresses socio-technical and cross-cutting aspects has contributed to create a dialogue between representatives from Industry, Academic research, EU policy and key societal stakeholders. The goal was to better understand the needs and concerns of these stakeholders, so that their interests can be reflected in the development of solar fuel technologies and has been pivotal to listen to new societal actors that will be taken into account in future actions of the project.

These central events, together with the national and regional meetings organized during this period, have served to attract **attendees from more than 60 new organizations beyond partners and supporters**.

One of the goals of the SUNER-C project is to develop a searchable database for mapping the solar fuels and chemicals community. A first version of this community mapping exercise is already available on the website. Partners and supporters have firstly been approached to list the competencies they can contribute with in the area of solar fuels and chemicals, trying to cover all the value chain. The second step, includes contacting the new actors already identified in this first period and to expand those, especially targeting industry and societal stakeholders. Therefore, aiming to enlarge the community with more active supporters. The identification of related projects within the WP2 portfolio, is also expected to have a positive impact towards involving new stakeholders from the identified project's participants (ca. 28 new organizations).

Changes to the expected outcome: At the proposal stage it was set a target of reaching 600+ stakeholders. This was realistic when preparing the proposal as it was still open for a LSRI in the form of a EU partnership. However, at the mid-term of the project, we know that our proposition of a co-programmed public-private partnership is not selected for the second wave of partnerships in Horizon Europe. This might have a negative effect in the attractiveness of SUNER-C and the SUNERGY initiative for potential stakeholders. We will of course maintain the effort to achieve a high number of active supporters for the initiative, and we will draft a strategy to this end. Including the involvement of the new actors already identified and closely related with the community mapping exercise. Given the current circumstances, though, we believe that a **revised lower target of 400+** engaged stakeholders appears to be more realistic.

❖ **Global outreach**

At the end of the mid-term period the SUNER-C community includes organizations from **18 European countries**, Portugal has been added since the proposal stage, and the United Kingdom is now counted within the other international countries that have increased up to **16 countries, including Uganda and New Zealand** as the latest countries added.

The European countries with more organizations represented in the SUNER-C ecosystem are Germany, Spain, France, Belgium, Italy, Netherlands, and Poland, showing a good geographical distribution, although overall representation from East European countries could still be improved. This will be among the targets of the second half of SUNER-C.

❖ **Cooperation with other initiatives & projects**

All relevant EU partnerships, missions, platforms and major projects

Cooperation focused so far mainly on EU partnerships and on platforms, at the national and EU levels. The most relevant EU partnership is Processes4Planet, which covers (solar) chemicals. There were institutional-level interactions and discussions between SUNERGY/SUNER-C and P4P to discuss on complementarity and synergies. Additionally, some members of the SUNER-C consortium who organization is part of P4P also contribute to P4P activities (e.g. elaboration of the roadmap and SRIA) to ensure complementarity.

Another important partner for cooperation is the AMI2030 materials initiative, which is expected to lead to a co-programmed European partnership starting in 2025. There are established connections with this initiative - the current chair of AMI2030 is member of the SUNER-C international advisory board – and cooperation will continue through SUNER-C contributions to the AMI2030 SRIA and roadmap.

Additionally, other relevant EU partnerships include Clean Hydrogen, Clean Aviation, Clean Energy Technology partnership and Circular Bio-Based Europe. Formalized cooperation at the institutional level has yet to take place, but SUNER-C partners are involved in those partnerships and contribute to the activity, ensuring productive dialogue and co-information. Formal interactions at an organizational level will be considered during the second half of the SUNER-C project now that we have elaborated some plans for the future of the Initiative beyond the CSA.

For cooperation with major projects, the focus was mostly with national platforms relevant to the SUNERGY scope i.e. solar fuels and chemicals, see below.

At least 20 relevant major platforms in at EU level...

- CO₂ Value Europe (industry-driven initiative) which represents the European Carbon Capture and Utilisation (CCU) community. CVE is a member of the SUNER-C consortium
- European Energy Research Alliance and its Joint Programmes. EERA is a member of the SUNER-C consortium
- E-fuels Alliance: first contacts established when preparing the “Sustainable fuels” partnership proposal
- SUNERGY session at the EUTech Webinar
- Participation at events of EU-funded MSCA project Solar2Chem
- SUNERGY/SUNER-C Session at EuropaCat 2023, one of the largest academic catalysis community

... and at national level

- Solar fuels national academic networks for Sweden, France. Types of activities, seminars, round tables, etc. by SUNERGY/SUNER-C members
- Organization of national events in Poland, Netherlands, France, Sweden, Czech Republic (see above under WP5 the complete list of national events)
- Cooperation/participation to activities of National Alliances for Research on Energy, including ANCRE for France
- Involvement of the German DECHEMA platform as a SUNER-C partner
- Cooperation/participation to activities of local networks (seminars, participation to round tables) including the CDP DefiCO₂ of the Grenoble Alpes University

Connection with key international organizations and initiatives, and with one major initiative/platform in key non-EU countries

The key international organizations SUNER-C is in contact with are, as planned in the proposal the Mission Innovation Collaborate Platform “Sunlight-to-X.” and the International Energy Agency (IEA). More details on the actions done so far are given in section 1.2.1 of this report, in the section on sub-Task 1.3.2.

Additionally, SUNER-C has established contact with the UK Solar Chemicals network with the idea of keeping contacts with the UK solar fuels & chemicals community. The UK Solar Fuels network has provided a LoS to SUNERGY to formalize connection, and vice-versa. The director joined SUNER-C events as the last General Assembly end of 2023. Both SUNER-C and the UK Solar Fuels network are participating to the already mentioned Mission Innovation Collaborate Platform “Sunlight-to-X.” in particular to elaborate a global roadmap for this Platform. Moreover, to maintain contacts with the UK Solar Fuels community, we have a recognized British scientist in the International Advisory Board of SUNER-C, Professor James Durrant (Imperial College London) who contributed to several SUNER-C meetings and events, and presented a seminar of general interest.

Changes to the expected outcome: the most likely outcome for an LSRI after SUNER-C was a European partnership. While no official assessment of SUNER-C's efforts towards such a partnership has been formulated by the EC as of the writing of this report, it seems likely that this partnership will not be an option, or at least not in 2025. We might have to reconsider and prioritize our objectives in terms of cooperation as we adapt to new options for a LSRI. This will be one of the key priorities as we enter the second half of this project.

Roadmap

❖ A roadmap covering 2022-2050 and updated every two years, endorsed by stakeholders.

The first version of the SUNER-C roadmap was prepared by the SUNER-C consortium within WP3, with participation from numerous stakeholders and co-authors. This constituted D3.1 which was submitted in November 2023. This roadmap is built from the SUNERGY SRIA published in November 2022 and is to be updated by the end of the SUNER-C project, then every two years subsequently.

❖ Targeting >50 new topics on solar fuels & chemicals for HE Work Programmes up to 2027

So far, we can provide figures for 2021-2024, looking at topics referring to solar fuels and chemicals and part of the Work Programmes of Pillars 2 (Clusters 4 and 5) and pillar 3 (EIC). When compiling the data, there have been **9 topics brought forward by the SUNERGY community**, representing 32 funded projects (see table below).

Pillar	Cluster, programme	Topic	Remark	Number of projects submitted	Number of projects selected	Total budget (M€)
2	4	HORIZON-CL4-2021-RESILIENCE-01-14: Development of more energy efficient electrically heated catalytic reactors	Ramp-up phase - SUNERGY topic 1	8	3	33
2	4	HORIZON-CL4-2021-RESILIENCE-01-16: Creation of an innovation community for solar fuels and chemicals	Ramp-up phase - SUNERGY topic 5	2	1	4
2	5	HORIZON-CL5-2021-D3-02-03: Hybrid catalytic conversion of renewable energy to carbon-neutral fuels	Ramp-up phase - SUNERGY topic 2	24	3	10
2	4	HORIZON-CL4-2022-TWIN-TRANSITION-01-15: New electrochemical conversion routes for the production of chemicals and materials in process industries	Ramp-up phase - SUNERGY topic 3 & P4P partnership	15	3	28
2	5	HORIZON-CL5-2022-D3-03-03: Efficient and circular artificial photosynthesis	Ramp-up phase - SUNERGY topic 4	15	2	10
2	5	HORIZON-CL5-2023-D3-02-08: Development of microalgae and/or direct solar fuel production and purification technologies for advanced aviation and /or shipping fuels			2	8
2	5	HORIZON-CL5-2024-D3-01-04: Improvement of light harvesting and carbon fixation with synthetic biology and/or bio-inspired//biomimetic pathways for renewable direct solar fuels production			2	8
3	EIC	EIC 2022 PATHFINDERCHALLENGES-01-01 Carbon dioxide and Nitrogen management and valorisation		100	8	27,4
3	EIC	EIC 2024 PATHFINDERCHALLENGES Solar-to-X devices for the decentralized prosumption of renewable fuels, chemicals and materials as climate change mitigation pathway	Budget is estimated based on previous similar funding		8	30
				Total	32	158,4

For 2025-2027, SUNERGY Is proposing several new topics on solar fuels and chemicals to be considered, including 5 for the HE Work Programme 2025.

❖ Indicative estimate of mobilised funding & investments for the projects (RIAs, IAs)

- **Public funding on solar fuels and chemicals:** The target here was ca. 1 bnEUR over 7 years, or ca. 70 MEUR/year. The 32 funded projects mentioned above come up to a **total budget of approx. 160 M€ (i.e. approx. 40 M€/year over the period 2021-2024, see table above)**. NB: as some calls are in 2024, these are tentative figures as these include some estimates based on the total budgets per topic and average expected budget per project.
- **Private investments:** The target here was ca. 1 bn EUR over 7 years, or ca. 70 M EUR/year. This is an ambitious target rooted in the expectations of EC financing of a LSRI with the matching industrial investments that such instruments trigger. We will report on this metric at the end of the project once we have a clearer idea of the future funding of R&I the SUNERGY initiative, with relevant co-financing rates informing industry financing. Of note, relevant to this topic of private investments, SUNER-C partner CVE is in the process of mapping industrial investments in the field of CCU all over the EU and globally (<https://database.co2value.eu/projects>).

Changes to the expected outcome: the initial targets for these metrics, both in terms of number of topics and overall funding and investments, were quite ambitious and scaled with the objective of a larger initiative as a partnership. In the eventuality of a lack of support from the EC through a realistic path to an adapted instrument as an LSRI, these targets will likely have to be revised and lowered.

1.3.3 Wider, longer-term scientific, technological, impacts

❖ SUNER-C main scientific and technological impacts

The impact of the SUNER-C project is mainly to create and structure a network for a diverse community to meet and build a strategic R&D roadmap in the field of solar fuels and chemicals, and beyond. The various players brought together, from the academic, industrial and societal worlds, come from different communities and don't necessarily have many opportunities to meet. The SUNER-C events provide a structuring framework for this by tackling different topics. During this first period, one of the key actions structuring the scientific and technological impact of the project was the construction of the SRIA and the drafting of a first version of the roadmap, as well as the determination of a common vision.

❖ SUNER-C main industrial and economic impacts

We developed a strategy for an LSRI beyond the SUNER-C project to meet the needs of the industrial world in the field and in phase with major European challenges, notably supporting Europe's increased autonomy in key strategic value chains, competitiveness of European chemical and materials industry and European leadership in the circular economy. This required an analysis of the existing landscape of LSRIs, in order to make a proposal that would complement and synergize them and avoid duplication, while also taking into account the needs of industrialists and consulting them. The "Sustainable fuels as energy carriers" co-programmed partnership proposal was thus co-constructed with and supported by key industrial players. However, our partnership proposal was not included in the second wave of Horizon Europe partnerships. The aim remains to capitalize on this work for the rest of the project and beyond, to ensure maximum impact. In terms of economic impact, it is currently too early to comment at this stage of the project.

❖ SUNER-C main societal impacts

Through events and working sessions, the SUNER-C consortium and the SUNERGY community have initiated a much-needed dialogue between social science players and representatives of the general society to discuss the potential impact of the technologies developed in the project. This dialogue involves finding a common language in which to exchange views on the potential impacts of scaling up the manufacture of solar fuels and chemicals as we aim to replace fossil intrants, the benefits and drawbacks this proposed paradigm shift inherently brings, real potential consequences on different actors of civil society, and which economic sectors to target to maximize beneficial impacts. To this end, a number of actions have been initiated, including a preliminary analysis of the key cross-cutting aspects and players linked to the project theme, the development of a conversation tool to address these points, and a stakeholder dialogue workshop. It emerged that, in terms of prioritizing sectors for the application of solar fuels and chemicals, there seems to be an overall consensus on certain sectors, such as maritime and air transport and high-volume road transport, or certain industrial sectors that are difficult or impossible to decarbonize through electrification or hydrogen, such as the chemical, cement or steel industries. Other sectors, such as individual road transport, are for most players a source of questioning, if not outright opposition. Such lessons are extremely valuable to learn when proposing technological change, and are underestimated in consortia composed exclusively of R&I experts (academic or industrial).

HISTORY OF CHANGES		
VERSION	PUBLICATION DATE	CHANGE
1.0	08.01.2024	Initial draft – N. Coutard (UU), all WP leaders
1.1	12.01.2024	Revised draft – N. Coutard (UU), L. Lopez (ICIQ), F. Chandezon (CEA)
2.0	16.01.2024	Version submitted on GMS – N. Coutard (UU), L. Lopez (ICIQ), F. Chandezon (CEA), T. Verspandoonk (UU)