SUNER-C

Deliverable 2.1 (D4): List of projects in the portfolio at mid-term

Funded by
The European Union,
Grant Agreement No. 101058481

www.sunergy-initiative.eu/suner-c

Table 1

Project Summary	
Project Number	101058481
Project Acronym	SUNER-C
Project Name	SUNER-C: SUNERGY Community and eco-system for accelerating the development of solar fuels and chemicals
Starting date	01/06/2021
Duration in months	36
Call (part) identifier	HORIZON-CL4-2021-RESILIENCE-01
Topic	HORIZON-CL4-2021-RESILIENCE-01-16
Type of action	HORIZON-CSA (Coordination and Support Actions)
Service	HADEA/B/03

Disclaimer

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Table 2

Management Information	
Version 1	September 30th 2023
WP	2 – Ongoing research activities in the EU
Lead and co-lead beneficiaries	**ERIC**, UTU, UU, CEA, ICIQ, IMDEA, AD, with minor (≤ PMs) contributions of GU, LU, DECH, HIPC, CVE, IMEC, SYN, AM, ENGIE, TOTAL
Dissemination Level	Public
Deliverable Number	D2.1 (D4)
Type, and Responsible	Report, ERIC
Deliverable Name	List of projects in the portfolio at mid-term
Due date	30 November 2023 (M18)
Abstract	This deliverable reports the activities made within Task 2.1 to create a portfolio of projects related to the core objectives of SUNER-C, first by mapping the relevant EU (mainly) projects to engage them to participate in SUNER-C activities, build synergies and share actions to support CSA priorities. It also reports the activities made up to the Midterm to identify common KPIs related to the CSA's vision/roadmap (Task 2.2) and foster synergies among them (Task 2.3).

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Table 3

Document History			
Version	**Date**	**Responsible**	**Action**
1	30/9/23	ERIC	The first version of the Deliverable
2	3/10/23	UT	Project portofolio is updated with more details
3	25/10/23	ERIC	Revised based on the feedback received
4	16/11/23	ERIC	Revised based on the feedback from Q&IA team

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Table 4

Consortium Information	
Coordinator:	1. UNIVERSITEIT UTRECHT (UU)
Beneficiaries:	2. COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES (CEA) 3. EUROPEAN RESEARCH INSTITUTE OF CATALYSIS A.I.S.B.L. (ERIC) 4. UNIVERSITEIT GENT (GU) 5. UNIVERSITEIT LEIDEN (LU) 6. UNIWERSYTET WARSZAWSKI (UW) 7. FUNDACIO PRIVADA INSTITUT CATALA D'INVESTIGACIO QUIMICA (ICIQ) 8. SIEMENS ENERGY GLOBAL GMBH & CO. KG (SE) 9. DECHEMA GESELLSCHAFT FUR CHEMISCHETECHNIK UND BIOTECHNOLOGIE (DECH) 10. FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG EV (Fraunhofer) 11. CARBYON BV (CAR) 12. TURUN YLIOPISTO (UTU) 13. USTAV FYZIKALNI CHEMIE J. HEYROVSKEHO AV CR, v. v. i. (HIPC) 14. UPPSALA UNIVERSITET (UppU) 15. COVESTRO DEUTSCHLAND AG (COV) 16. CO2 VALUE EUROPE AISBL (CVE) 17. FUNDACION IMDEA ENERGIA (IME) 18. ALMA DIGIT SRL (AD) 19. INTERUNIVERSITAIR MICRO-ELECTRONICA CENTRUM (IMEC) 20. AVANTIUM CHEMICALS BV (AVT) 21. NEXTCHEM S.P.A. (NEXT) **- withdrawn** 22. ALLIANCE EUROPEENNE DE RECHERCHE DANS LE DOMAINE DE L'ENERGIE (EERA) 23. SYNERGEIES STIN EPISTIMI KAI TECHNOLOGIA-SYNEST IDIOTIKI KEFALAIOUCHIKI ETAIREIA (SYN) 24. UNIVERSITATEA DIN BUCURESTI (UB) 25. ARCELORMITTAL BELGIUM NV (AM) 26. VICAT (VIC) 27. BELGISCH LABORATORIUM VAN ELEKTRICITEITSINDUSTRIE (ENGIE-LAB) 28. ENGIE (ENGIE) – **Affiliate Entity** 29. RHODIA OPERATIONS (SOLVAY) 30. BOND BETER LEEFMILIEU VLAANDEREN (BBL) 31. TOTALENERGIES ONE TECH BELGIUM (TEOTB) -- **Associated Partner**

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Executive summary

This document (D2.1 - List of projects in the portfolio at mid-term) is a deliverable of the SUNER-C project, which the European Union's Horizon Europe funds under Grant Agreement No 101058481.

The main objective of the SUNER-C "List of projects" is to ensure that the CSA realises strong synergies with other EU (mainly) projects in the area, and at the same time, it promotes their interaction to accelerate the progress in the area of solar fuels. The objective is first to map the landscape of R&D EU projects, contributing to advancing the priorities identified in the vision and SUNER-C SRIA. Then, after selecting and engaging the projects interested in joining and collaborating with SUNER-C (WP2), promote common activities among them and with SUNER-C to i) identify their KPIs and their contribution to SUNER-C' KPIs, ii) promote the exchange of non-confidential knowledge and expertise which can foster projects' and whole area progress in relation to the timescale of SUNER-C roadmap, and iii) create actions to enhance synergies between projects in order to accelerate the realisation of common objectives;

This deliverable reports the activities made within Task 2.1 to create a portfolio of projects related to the core objectives of SUNER-C, first by mapping the relevant EU (mainly) projects to engage them to participate in SUNER-C activities, build synergies and share actions to support CSA priorities. It also reports the activities made up to the Midterm to identify common KPIs related to the CSA's vision/roadmap (Task 2.2) and foster synergies among them (Task 2.3).

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List of abbreviations

List of abbreviations	
EIC	European Innovation Council
LSRI	Large-scale research and innovation initiative
KPI	Key performance indicators
SF	Solar fuels
SRIA	Strategic research and innovation agenda

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1. Introduction

1.1. SUNER-C in a shot

SUNER-C is a project that has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101058481. The project has officially started on June 1st 2022 and will last 36 months. Under the umbrella of the SUNERGY pan-European initiative, the newly funded SUNER-C programme entitled "SUNERGY Community and eco-system for accelerating the development of solar fuels and chemicals" will strengthen the solar fuels and chemicals community within Europe. The European Union has awarded 4 M€ to this project.

The SUNER-C consortium is a unique and balanced partnership of 31 organisations (including one affiliate and one associate partner), bringing together a large diversity of partners, expertise, fields, and representatives of all the EU regions. The consortium consists of 13 academic partners (UU, CEA, GU, LU, UW, ICIQ, Fraunhofer, UTU, HIPC, UppU, IME, IMEC, UB), 12 industrial companies (SE, CAR, COV, AD, AVT, NEXT (withdrawn), SYN, AM, TEOTB, VIC, ENGIE-Lab, ENGIE, SOLVAY), 4 network organisations and federations (ERIC, DECH, CVE, EERA), and 1 Non-Governmental Organization (BBL).

The overarching objective of the SUNER-C project is to create an inclusive innovation community and eco-system that builds on the current SUNERGY network and includes new stakeholders across Europe. Bringing together fundamental and applied knowledge from various sectors of society as well as often unique resources, the enhanced community will prepare a Large-Scale Research and Innovation initiative (LSRI) 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. The goal is to overcome scientific, technological, organisational, and socio-economic challenges, accelerate innovation in solar fuels and chemicals, and enable the transition of existing and future technologies from laboratory and demonstrator levels to large-scale industrial and broad societal applications.

The SUNER-C consortium will also work on the development of a strategic roadmap towards the broad implementation of solar fuels and chemicals, with supporting strategies for innovation and exploitation and a firm focus on crosscutting and socio-technical aspects.

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Through a holistic approach, SUNER-C will contribute to a circular economy by replacing fossil-derived fuels and chemicals with renewables and carbon recycling as a key element toward the EU net-zero emissions target by 2050. SUNER-C will build upon the work of SUNERGY, a pan-European initiative on fossil-free fuels and chemicals from renewable power and solar energy, with currently over 300 supporting organisations across and beyond Europe to date.

Figure 1 represents an overview of the work package structure of SUNER-C with its eight WPs. The WP2 (Ongoing research activities) is part of the general O1 (Create a fully inclusive innovation eco-system for solar fuels and solar chemicals) objective of SUNER-C, with the specific role of mapping EU (mainly) projects to identify key players, stimulating collaboration and creating synergies. The
deliverable D2.1, "List of projects in the portfolio at mid-term" is a deliverable of WP2 reporting the activities within Task 2.1 (Project portfolio), and the initial activities to Midterm related to other tasks of WP2 active up to Midterm, e.g. Task 2.2 (KPIs and project portfolio monitoring), and Task 2.3 (Fostering project synergies). Task 2.4 (Standardisation of protocols) started at M13. Tasks 2.2 and 2.3 will report mainly in Deliverable D2.2, due at M30 (KPIs and actions realised to foster synergies between projects of the portfolio, responsible UT). Task 2.4 will be reported in Deliverable 2.3, due at M36 (Standardised protocols and KPIs for comparing results and experiments, responsible IMDEA).
There are no milestones associated to WP2.

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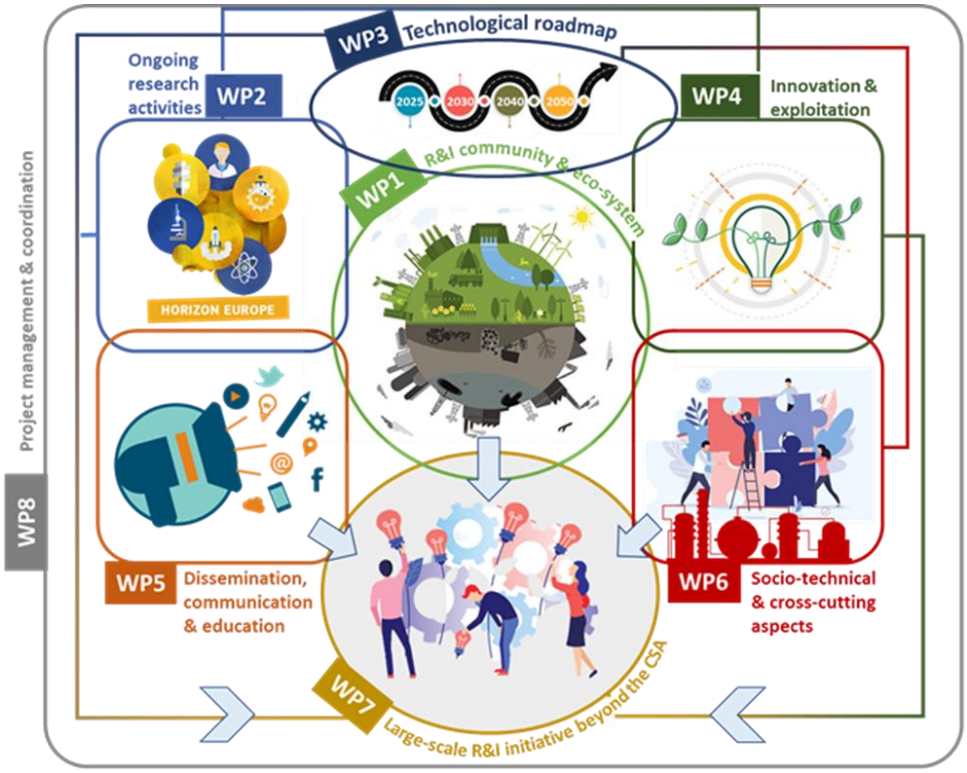

Figure 1: SUNER-C CSA project and its eight work packages. The List of projects in the portfolio at mid-term (D2.1) is a deliverable of WP2 "Ongoing research activities in the EU"

1.2. Purpose of the Deliverable

This deliverable reports the actions made to identify and prepare a project portfolio of (mainly) EU projects with core activities on the aspects identified in the vision and SRIA SUNER-C documents, briefly summarised with the term "solar fuels".

The main objective of the SUNER-C "List of projects in the portfolio at midterm" is to ensure that the CSA realises strong synergies with other EU (mainly) projects in the area, and at the same time, it promotes their interaction to accelerate the progress in the area of solar fuels. The objective is first to map the landscape of R&D EU projects, contributing to advancing the priorities identified in the vision and SUNER-C SRIA. Then, after selecting and engaging the projects interested in joining and collaborating with SUNER-C (WP2), promote common activities among them and with SUNER-C to i) identify their KPIs and their contribution to SUNER-C' KPIs, ii) promote the exchange of non-confidential knowledge and expertise which can foster projects' and whole area progress in relation to the timescale of SUNER-C roadmap,

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and iii) create actions to enhance synergies between projects in order to accelerate the realisation of common objectives;

1.3. Interconnection with other activities in the project

Identifying and creating a project portfolio of EU (mainly) projects sharing the SUNER-C vision and SRIA is a core element of WP2 (Ongoing research activities in the EU, responsible ERIC). However, these activities are horizontal in the project. They are interrelated (Figure 1) with activities mainly with WP1 (Creation of a research and innovation community and eco-system, responsible LU) and WP3 (Long-term technological roadmap, responsible UW), with impact on WP4 (Innovation and exploitation, responsible SE) and WP7 (Large-scale R&I initiative beyond the CSA, responsible CEA). The WP2 activities are supported by WP5 (Dissemination, communication and education, responsible CVE) regarding the organisation of workshops and webinars. This plan will be updated throughout the duration of the CSA according to findings on new projects to be involved in the portfolio.

2. Strategy to map the EU landscape on solar fuels

2.1 Goals and Objectives

The main objectives of the SUNER-C project portfolio are:

- To map the landscape of R&D EU (mainly) projects contributing to the advancement of the priorities as identified in the vision and SUNER-C SRIA;
- To use this project portfolio to i) identify their KPIs and contribution to SUNER-C' KPIs, ii) monitor projects' progress in relation to the timescale of SUNER-C roadmap, iii) foster synergies between projects to accelerate the realisation of common objectives, iv) promote multisectoral project relations, in particular with digitalisation area, v) identify and foster interactions between EU projects and those at the national level (large national projects

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2.2 Strategy to map the EU landscape on solar fuels

Using publically available data (taken from CORDIS) on EU-funded projects that include "solar fuels" among their keywords, we have identified 278 projects manually scrutinised to identify a first series of 124 projects more pertinent. We have reached out to the coordinators of these financed projects to get more information about their work's main results/targets and get feedback about their indications for future investment areas and the main gaps and new trends they suggest. However, only a part of these projects does not give feedback.

Another approach used was to search in CORDIS Datalab with the keywords "solar fuel" projects having them in the title and objectives. The results are summarised in Figure 2. Sixty projects were identified involving 188 organisations, most in the EU but with several partners worldwide. A good geographical distribution within the EU can be observed, with Spain, UK, Italy, Germany, Belgium, and The Netherlands as the countries with more organisations involved. However, some projects identified with the two approaches do not overlap.

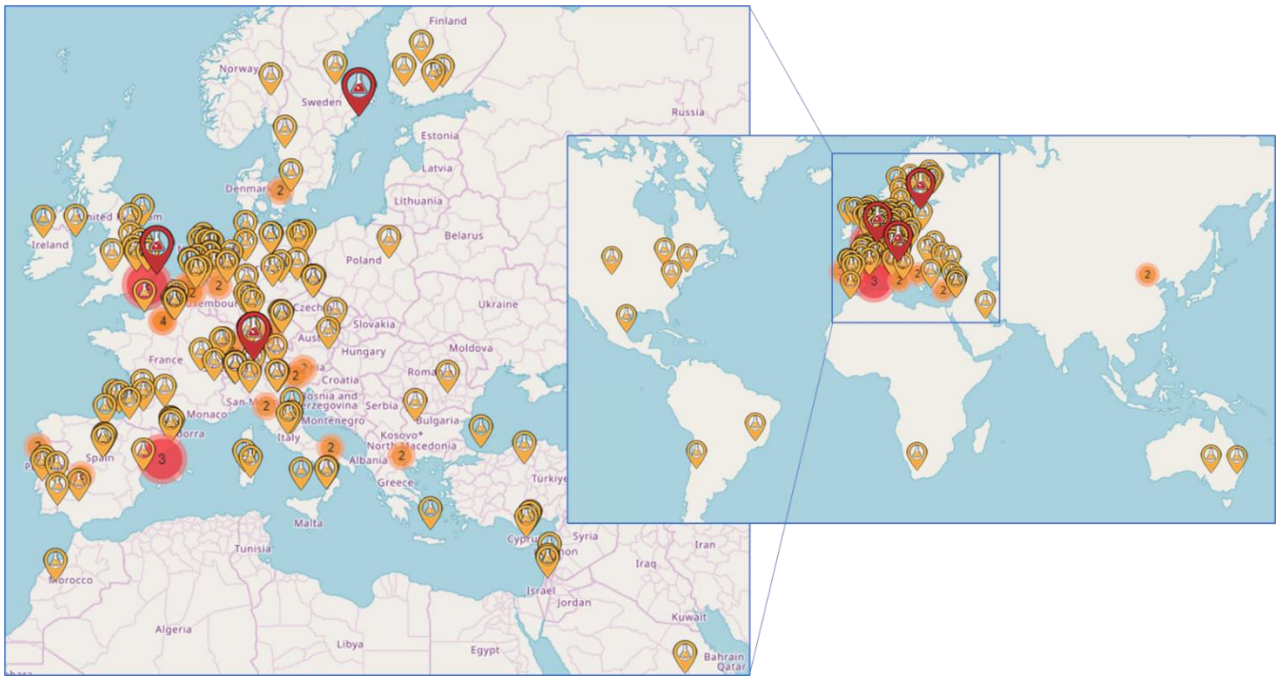

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Figure 2: Geographical distribution of the 188 organisations involved in 60 EU-financed projects with the keywords "solar fuel" in the title and objectives. From CORDIS Datalab on 08/04/2023

Combining the two approaches, we thus obtained a first list of EU-financed projects on "solar fuels" limited to projects active from 2021 up to April 2023. The list was presented to the SUNER-C board to obtain further inputs. This list reports the projects where the concept of solar fuels is explicitly indicated and verified from the manual analysis of the project abstract. It also includes most of the projects on artificial photosynthesis research, although these keywords are too restricted. Additional projects on the topic may be possible if they do not have a direct relation to the concept of solar fuels in the title and abstract.

The list (Table 5) also reported the Institutions and countries involved, the acronym and title of the project, the total cost of the project and EU contribution to the specific beneficiary, the start and ending date for the project, the acronym of the call (topic) and finally an indication of the TRL range. This list allowed for making a first series of valuable general information.

During the Suner-C meeting in Brussels on 15-16th Feb. 2023, in a dedicated breakout session, the strategy of WP2 in creating a portfolio of projects on SFs and the list of potential projects reported in Table 5 was discussed. It was remarked that, however, only about 20 of the projects in this list gave positive feedback that they were interested in participating in Suner-C WP2 activities.
The breakout session thus discussed the following aspects

- how to be effective in the analysis of project portfolio's to identify (running) projects closely related to SUNER-C
- how to identify other projects of relevance part of other EU HE calls
- how to identify transnational or national other (large) projects of relevance (Kopernicus project, Germany, as an example)

The main problem identified was involving these projects effectively and raising their interest. The general strategy to adopt is summarised below:

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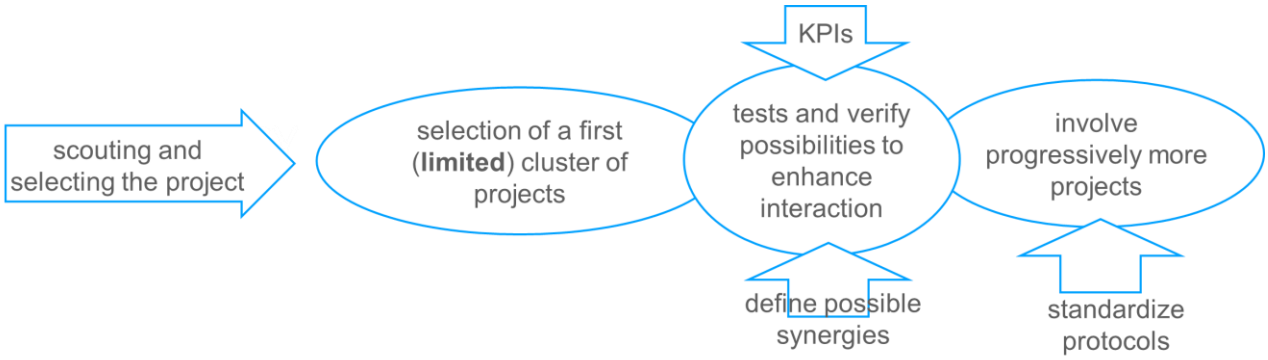

The breakout session continued with analysing the EIC project portfolios to identify (running) projects closely related to SUNER-C. In particular, the following EIC thematic portfolios were analysed:

- renewable hydrogen
- energy storage
- solar conversion technologies
- energy harvesting and conversion

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Table 5 - List of EU projects related to solar fuels (active 2021- April 2023) – only coordinating Institutions (list with partners available)

Org id	Org name	City	Country	Proj id	ACRONYM	Proj title	Type of participation	Total EU Contribution	EU Contribution	Start date	End date	Topic(s)	TRL
999977172	THE CHANCELLOR MASTERS AND SCHOLARS OF THE UNIVERSITY OF CAMBRIDGE	CAMBRIDGE	UK	670405	EXMOLS	Excited electronic states in extended molecular systems	coordinator	2.499.836 €	2.499.836 €	01/10/2015	30/09/2021	ERC-2014-ADG	<3
999981634	WAGENINGEN UNIVERSITY	Wageningen	NL	682444	E-MOTION	Electro-motion for the sustainable recovery of high-value nutrients from waste water	coordinator	1.950.000 €	1.950.000 €	01/11/2016	31/10/2022	ERC-2015-CoG	<3
999985029	UPPSALA UNIVERSITET	Uppsala	SE	681895	MOFCat	Fundamental and Applied Science on Molecular Redox-Catalysts of Energy Relevance in Metal-Organic Frameworks	coordinator	1.968.750 €	1.968.750 €	01/01/2017	31/12/2021	ERC-2015-CoG	<3
999973971	ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE	Lausanne	CH	681292	FANOEC	Fundamentals and Applications of Inorganic Oxygen Evolution Catalysts	coordinator	2.199.983 €	2.199.983 €	01/07/2016	30/06/2021	ERC-2015-CoG	<3
999977172	THE CHANCELLOR MASTERS AND SCHOLARS OF THE UNIVERSITY OF CAMBRIDGE	CAMBRIDGE	UK	682833	MatEnSAP	Semi-Artificial Photosynthesis with Wired Enzymes	coordinator	1.960.289 €	1.960.289 €	01/10/2016	31/03/2023	ERC-2015-CoG	<3
999990655	DANMARKS TEKNISKE UNIVERSITET	KONGENS LYNGBY	DK	741860	CLUNATRA	Discovering new Catalysts in the Cluster-Nanoparticle Transition Regime	coordinator	2.500.000 €	2.500.000 €	01/09/2017	30/06/2023	ERC-2016-ADG	<3
999977172	THE CHANCELLOR MASTERS AND SCHOLARS OF THE UNIVERSITY OF CAMBRIDGE	CAMBRIDGE	UK	835073	BATNMR	Development and Application of New NMR Methods for Studying Interphases and Interfaces in Batteries	coordinator	3.498.219 €	3.498.219 €	01/10/2019	30/09/2024	ERC-2018-ADG	<3

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999997930	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	Paris	FR	804320	2D-4-CO2	DESIGNING 2D NANOSHEETS FOR CO2 REDUCTION AND INTEGRATION INTO vdW HETEROSTRUCTURES FOR ARTIFICIAL PHOTOSYNTHESIS	coordinator	1.499.931 €	1.499.931 €	01/01/2019	31/12/2023	ERC-2018-STG	<3
999446000	HELMHOLTZ-ZENTRUM BERLIN FUR MATERIALIEN UND ENERGIE GMBH	Berlin	DE	804092	ME4OER	Mechanism Engineering of the Oxygen Evolution Reaction	coordinator	1.499.980 €	1.499.980 €	01/03/2019	29/02/2024	ERC-2018-STG	<3
999662601	UNIVERSITA DEGLI STUDI DI MESSINA	Messina	IT	810182	SCOPE	Surface-COnfined fast-modulated Plasma for process and Energy intensification in small molecules conversion	coordinator	9.979.269 €	2.491.413 €	01/04/2019	31/03/2025	ERC-2018-SyG	<3
999979888	TECHNISCHE UNIVERSITAET WIEN	WIEN	AT	864991	CARBOFLOW	Streamlined carbon dioxide conversion in ionic liquids â€"a platform strategy for modern carbonylation chemistry	coordinator	1.963.515 €	1.963.515 €	01/01/2021	31/12/2025	ERC-2019-COG	<3
999993468	IMPERIAL COLLEGE OF SCIENCE TECHNOLOGY AND MEDICINE	LONDON	UK	850624	THEIA	Design and engineering of porous nitride-based materials as a platform for CO2 photoreduction	coordinator	1.498.934 €	1.498.934 €	01/02/2020	31/01/2025	ERC-2019-STG	<3
999847677	QUEEN MARY UNIVERSITY OF LONDON	LONDON	UK	101001626	FENCES	Ferroelectric Nanocomposites for Enhanced Solar Energy Efficiency	coordinator	1.999.903 €	1.999.903 €	01/06/2021	31/05/2026	ERC-2020-COG	<3
999990655	DANMARKS TEKNISKE UNIVERSITET	KONGENS LYNGBY	DK	101040153	CROVETTO	Inverse Design of Optoelectronic Phosphosulfides	coordinator	2.263.750 €	2.263.750 €	01/01/2023	31/12/2027	ERC-2021-STG	<3

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999512057	USTAV ORGANICKE CHEMIE A BIOCHEMIE, AV CR, V.V.I.	PRAHA 6	CZ	101041554	SOLBATT	Storage of Electrons into Chemical Bonds: Towards Molecular Solar Electrical Batteries	coordinator	1.449.034 €	1.449.034 €	01/07/2022	30/06/2027	ERC-2021-STG	<3
999977463	TECHNISCHE UNIVERSITAET MUENCHEN	Muenchen	DE	101076858	DynNano	Understanding Dynamic Processes at Nanoscale Working Interfaces for Solar Energy Conversion	coordinator	1.988.500 €	1.988.500 €	01/10/2023	30/09/2028	ERC-2022-STG	<3
932760440	TEKNOLOGIAN TUTKIMUSKESKUS VTT OY	Espoo	FI	899576	FuturoLEAF	Leaf-inspired nanocellulose frameworks for next generation photosynthetic cell factories	coordinator	2.949.433 €	946.856 €	01/09/2020	31/08/2023	H2020-FETOPEN-2018-2020	<3
999446000	HELMHOLTZ-ZENTRUM BERLIN FUR MATERIALIEN UND ENERGIE GMBH	Berlin	DE	840751	HOCOM	A Transparent Hole Conductor by Combinatorial Techniques for Next-Generation Energy Conversion Devices	coordinator	212.239 €	212.239 €	01/09/2019	31/03/2022	H2020-MSCA-IF-2018	<3
999973971	ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE	Lausanne	CH	838686	CF-CO2R	Catholyte-free flow cell enables high efficiency electroreduction of CO2 to C2 fuels	coordinator	191.149 €	191.149 €	15/06/2019	14/06/2021	H2020-MSCA-IF-2018	<3
999651931	VIB VZW	ZWIJNAARDE - GENT	BE	840638	InVivoRuBisCO	In vivo Directed Evolution of Ribulose-1,5-Bisphosphate Carboxylase/Oxygenase in Saccharomyces cerevisiae Using an Orthogonal DNA Replication System	coordinator	178.320 €	178.320 €	01/12/2020	30/11/2022	H2020-MSCA-IF-2018	<3
999977754	POLITECNICO DI TORINO	TORINO	IT	843439	LuSH Art	Luminescent Solar Heterostructures for Artificial photosynthesis	coordinator	171.473 €	171.473 €	16/03/2020	30/05/2022	H2020-MSCA-IF-2018	<3

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999979015	EIDGENOESSISCHE TECHNISCHE HOCHSCHULE ZUERICH	Zuerich	CH	832535	ECLIPSE	Towards Efficient Production of Sustainable Solar Fuels	coordinator	191.149 €	191.149 €	01/09/2019	31/08/2021	H2020-MSCA-IF-2018	<3
998756718	KEMIJSKI INSTITUT	Ljubljana	SI	841676	PhotoCatRed	Visible-light-driven Photocatalytic CO2 Reduction to Solar fuels by multinary N-Graphene based Heterostructure Composites	coordinator	162.040 €	162.040 €	01/08/2019	31/07/2021	H2020-MSCA-IF-2018	<3
999991334	KATHOLIEKE UNIVERSITEIT LEUVEN	Leuven	BE	891276	C[Au]PSULE	Crystal phase engineering of Au nanoparticles for enhanced solar fuel generation	coordinator	166.320 €	166.320 €	01/04/2020	31/03/2022	H2020-MSCA-IF-2019	<3
999977172	THE CHANCELLOR MASTERS AND SCHOLARS OF THE UNIVERSITY OF CAMBRIDGE	CAMBRIDGE	UK	890745	SmArtC	Development of a Semi-Artificial Chloroplast	coordinator	212.934 €	212.934 €	01/10/2020	30/09/2022	H2020-MSCA-IF-2019	<3
999993468	IMPERIAL COLLEGE OF SCIENCE TECHNOLOGY AND MEDICINE	LONDON	UK	886664	PolyNanoCat	Polymer Nanoparticle for Hydrogen Evolution	coordinator	224.934 €	224.934 €	01/01/2021	31/12/2022	H2020-MSCA-IF-2019	<3
999548044	FUNDACIO PRIVADA INSTITUT CATALA D'INVESTIGACIO QUIMICA	Tarragona	ES	101031365	SolTIME	Solar Fuel Generation through Photoelectrochemical Reduction of CO2 Using Copper Porphyrins in Molecularly Designed Reaction Environments	coordinator	172.932 €	172.932 €	01/09/2021	31/08/2023	H2020-MSCA-IF-2020	<3
999991722	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	Madrid	ES	101024839	PHOTOBIOCATH-CO2	Photocathode engineering for efficient photobioelectrochemical CO2 reduction to formate	coordinator	160.932 €	160.932 €	01/09/2021	31/08/2023	H2020-MSCA-IF-2020	<3

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999849811	UNIVERSITE DE PAU ET DES PAYS DE L'ADOUR	Pau	FR	765376	eSCALED	European School on Artificial Leaf : Electrodes Devices	coordinator	3.599.022 €	887.059 €	01/04/2018	30/09/2022	H2020-MSCA-ITN-2017	<3
999643492	MIDDLE EAST TECHNICAL UNIVERSITY	Ankara	TR	856619	SolarTwins	Solar Twinning to Create Solar Research Twins	coordinator	799.446 €	399.621 €	01/01/2020	30/06/2023	H2020-WIDESPREAD-2018-03	<3
999990267	MAX-PLANCK-GESELLSCHAFT ZUR FORDERUNG DER WISSENSCHAFTEN EV	MUNCHEN	DE	101063820	TRUSol	Towards Rational Understanding of the Fe-quarterpyridine-mediated CO2 Reduction to Solar Fuels	coordinator	173.847 €	173.847 €	01/08/2022	31/07/2024	HORIZON-MSCA-2021-PF-01	<3
999865234	UNIVERSIDAD DEL PAIS VASCO/ EUSKAL HERRIKO UNIBERTSITATEA	Leioa	ES	101046836	CATART	Reaction robot with intimate photocatalytic and separation functions in a 3-D network driven by artificial intelligence	coordinator	2.871.775 €	672.500 €	01/09/2022	31/08/2026	HORIZON-EIC-2021-PATHFINDEROPEN-01	<3
999988909	NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK TNO	DEN HAAG	NL	101015960	SPOTLIGHT	Disruptive photonic devices for highly efficient, sunlight-fueled chemical processes	coordinator	5.604.959 €	911.719 €	01/01/2021	31/12/2023	H2020-ICT-2018-20	3-5
999864846	UNIVERSITAT POLITECNICA DE VALENCIA	Valencia	ES	101022649	METHASOL	International cooperation for selective conversion of CO2 into METHAnol under SOLar light	coordinator	3.999.634 €	708.020 €	01/07/2021	31/12/2024	H2020-LC-SC3-2020-NZE-RES-CC	3-5
996524845	European Research Institute of Catalysis A.I.S.B.L.	Bruxelles	BE	862030	DECADE	DistributEd Chemicals And fuels production from CO2	coordinator	5.198.757 €	655.369 €	01/05/2020	30/04/2024	H2020-NMBP-	3-5

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						in photoelectrocatalytic DEvices						ST-IND-2019	
928030235	FUNDACIO EURECAT	CERDANYOLA DEL VALLES (BARCELONA)	ES	862192	SunCoChem	Photoelectrocatalytic device for SUN-driven CO2 conversion into green CHEMicals	coordinator	6.617.645 €	1.018.783 €	01/05/2020	30/04/2024	H2020-NMBP-ST-IND-2019	3-5
998376866	CONSORZIO INTERUNIVERSITARIO NAZIONALE PER LA REATTIVITA CHIMICA E LA CATALISI - CIRCC	BARI	IT	101083355	DESIRED	Direct co-processing of CO2 and water to sustainable multicarbon energy products in novel photocatalytic reactor	coordinator	3.058.753 €	768.750 €	01/11/2022	31/10/2026	HORIZON-CL5-2021-D3-03	3-5

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2.3 Considerations on the EU landscape on solar fuels

Figure 3 reports the breakdown of EU contribution to financed projects active 2021-April 2023 with the keyword Solar Fuel. Around 100 M€ projects were active in the period, around 60% of which had a more fundamental character (in the <3 TRL range), and the remaining a higher TRL, typically up to 5. Those indicated as TRLs 2-7 are related to a Coordination Support Action (CSA) dealing with a broad range of TRLs. This CSA (SUNER-C) aims to build a community and partnership on solar fuels. About 4% of the total EU investment is dedicated to this action.

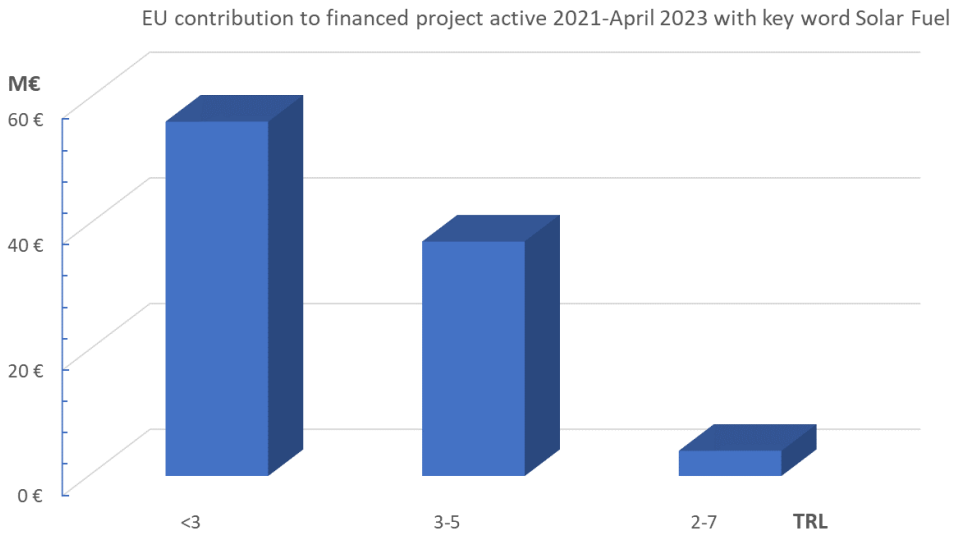

Figure 3 EU contribution to financed project active 2021-April 2023 with keyword Solar Fuel, according to the TRL level. Based on the data reported in Table 5

The projects active in SFs are thus most dedicated to fundamental research, but the fraction of activities at higher TRL is nevertheless significant. Several of these projects aim to build a small-scale pilot unit. However, among the projects listed in Table 1S, there are no activities at high TRL, in the 6-8 range. There is, thus, still a gap in moving to the commercialisation of SF technologies.

In terms of topics, together with a minority of projects aligned with the challenges identified in Table 5, several are oriented towards new ideas and pioneering research scarcely emerging from the literature or open patent analysis. Selected examples of these projects will be discussed below.

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2.4 Analysis of selected EU projects on solar fuels

An interesting example comes from the project SoFIA (Soap Film based Artificial Photosynthesis; https://sofiaproject.eu/), which proposes a technology paradigm shift in developing renewable solar fuel production, exploiting the unique self-assembling property of surfactants and proton transport properties in soap films. Their ambitious project concept is an economical artificial photosynthetic membrane with stable soap film with engineered photocatalytic surfaces. The concept mimics the light-sensitive part of leaves called the thylakoid membrane and uses molecular catalysts made from ruthenium and earth-abundant materials to form self-assembled catalytic surfaces at the junction between soap bubble pairs. Researchers plan to scale the technology by designing a stream of regenerative soap bubbles that can handle large volumes of gas, continuously flowing through a conduit exposed to light.

The idea of exploiting the properties of surfactant bubbles for introducing a new technology in the field of solar-to-fuel conversion is very innovative, which brings another challenge to pioneering research. Finding the proper experimental techniques and equipment when exploring new phenomena may be difficult, making pioneering research slower and time-consuming. A clear identification of the fundamental research needs to open breakthrough directions is not emerging in academic or more traditional roadmaps. The areas identified are the projection of current studies. Rather, creatively identifying the background knowledge for new research frontiers would be necessary. In many research projects, such as those discussed above and others below, the need to differentiate from mainstream pushes the researchers to a creative effort scattered along many not coherent directions. Accelerating the innovation process would require organising these creative ideas and making them synergetic with developing the fundamental background research. For the SoFIA project, there is a lack of knowledge in fundamental areas to develop and translate to application the concept of an artificial photosynthetic membrane in the form of stable soap film with engineered photocatalytic surfaces, and then make scalable by creating a dynamic stream of regenerative and stable soap foam capable of handling large volumes of gas, continuously flowing through light exposed conduits.

Another example is the project DECADE (DistributEd chemicals and fuels production from CO2 in photoelectrocatalytic devices; https://www.decadeproject.eu). Here, the concept is of a new PEC approach that maximises efficiency and reduces downstream costs. The device produces the same chemical on both sides of the electrocatalytic cell. It uses streams from biorefinery, and the product can be used as such with minimal downstream processing. The effluent from the electrocatalytic cell is an ethyl acetate solution with some side ethyl formate in ethanol (the

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reactant, together with CO2). It can be used directly as a green solvent or gasoline additive. The same concept can be used for the valorisation of methanol production rather than for biorefinery streams and other relevant cases, such as the production of glycolic acid at both electrocatalytic sides. Here, the main fundamental scientific issues, not addressed in the scientific literature, are i) how to overcome the low conductivity of not conventional electrolytes (ethanol, in this case) and ii) that the same electrocatalysts in these unconventional electrolytes (ethanol environment rather than an aqueous solution) change drastically their behaviour. This change is possibly related to the absence of the equilibria of CO2 with mono- and bi-carbonate present in water. Thus, new electrocatalytic chemistry and materials must be discovered, but the fundamental scientific bases are insufficient to design tailored electrocatalysts for operations under unconventional conditions and electrolytes.

SPOTLIGHT project (Disruptive photonic devices for highly efficient, sunlight-fueled chemical processes; https://spotlight-project.eu/) works on the design, manufacturing and validation of a photonic device that enables the sunlight-powered conversion of CO2 and green H2 to chemical fuels with a device efficiency of more than 5%. Because of its high photon-to-product efficiency and space-time yield, the technology concept selected for SPOTLIGHT's sunlight-powered catalytic conversion of CO2 and H2 to chemical fuels is 'plasmon catalysis'. Combining the chemical process concept based on plasmon catalysis with a highly innovative device concept for sunlight-powered chemical reactions, SPOTLIGHT can develop an efficient process for sunlight-powered production of chemicals and fuels from CO2 as starting material. Although plasmon catalysis is a topic with many studies in literature, the authors explore new unconventional aspects, again pushing the frontiers of fundamental research to novel directions rather than implementing fundamental research findings.

In solar-to-fuel conversion, a challenging topic is the realisation of efficient catalysts using abundant, cost-effective and environmentally friendly materials. Indeed, nature has provided us with some of the most efficient and sustainable catalysts, i.e., enzymes. Among all the existing natural enzymes, Laccase (Cu-based) is one of the most promising as it ensures fast reaction rates at low overpotentials. The idea of mimicking nature's approach has been the target of Cu4Peroxide ERC-PoC (The electrochemical synthesis of hydrogen peroxide) project and previous Cu4Energy ERC-STG (Biomimetic Copper Complexes for Energy Conversion Reactions). After realising that Cu-based catalysts always evolve hydrogen peroxide when reducing oxygen, the research team engineered a fast catalyst for this target reaction (with almost two million turnovers per second).

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Another project that exploits nature's lessons is PHOTOBIOCATH-CO2 (Photocathode engineering for efficient photobioelectrochemical CO_2 reduction to formate) where a hybrid organic/inorganic photoelectrode is used for CO_2 reduction reaction into formate. The most striking feature of this proposal is the kind of heterostructure that has been investigated: a carbon-based conductive nanomaterial (such as carbon nanotubes of reduced graphene oxide) on which the formate dehydrogenase enzyme is anchored. This layout allows a faster and more efficient charge transfer towards the catalyst without risking damaging it.

FuturoLEAF (https://futuroleaf.com/) proposes using a rather innovative approach: developing a 3D algae-based cell factory that can convert CO_2 and sunlight into valuable products such as biofuels and pharmaceuticals. Interestingly, the whole project makes huge efforts towards using sustainable materials to realise the whole system. Indeed, the engineered living cells are embedded in a polymer based on naturally occurring cellulose (the most used polymer before the synthetic petroleum-made plastics took over), which allows the selective transport of gas and nutrients to and from the algae. With this approach, photosynthetic microorganisms (e.g., cyanobacteria and microalgae) can be exploited for the efficient and sustainable production of isoprene, alcohols and other valuable compounds.

The area of biomimetic electrocatalysts, photobioelectrochemical, and algae-based cell factor are also well investigated in the literature. However, the cited projects are ahead and pushed to new research frontiers, opening new fundamental areas.

Another major role that CO2 can play in the chemical industry is as a source of carbonyl groups vital for producing many products. Indeed, nowadays, carbonylation industries use CO as a carbonyl source, although it is a toxic substance, leading to severe security issues. A possible alternative is using CO2, an abundant, non-toxic, non-flammable and renewable carbon source. However, CO2 is very stable. Thus, huge amounts of energy are required to overcome thermodynamic and kinetic barriers. The objective of CARBOFLOW (Streamlined carbon dioxide conversion in ionic liquids – a platform strategy for modern carbonylation chemistry) project is to explore a technology where mild conditions can reduce CO_2. In particular, their approach uses ionic liquid/photocatalyst composites (used as photocatalysts) to synthesise esters, amides and other chemicals by combining synergetically electrochemical and particulate photocatalysis routes. This is one of the projects pushing electrocatalysis and CO_2 utilisation to new directions that are still scarcely recognised in the literature.

These are examples of the various ones presented in Table 1, evidencing how research lines at the core of many research projects are ahead of the state-of-the-art research, not in terms of

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using the fundamental results towards application, but in opening new research directions not emerging from a literature survey and as such not outlined precisely in roadmap efforts. This indication also emerges from the feedback given by the questioned EU projects.

Another common issue is the lack of a standardised procedure for reporting the performances of solar-to-fuel conversion devices. Thus, there is an intrinsic difficulty in ranking them and evaluating new emerging directions. Indeed, different research groups usually discuss different figures of merit, sometimes focusing only on those parameters that favour the presentation of their results. It can also make reproducing many literature results difficult (sometimes impossible). This is particularly evident when comparisons of the performances of lab-scale prototypes are made with industrially available options: too many new proposed systems are not competitive or even close to the lowest requirements expected for the large-scale operation of new proposed technologies. Thus, a clear and standard procedure should be adopted worldwide to guarantee straightforward comparisons and the real impact of new approaches/materials/technologies. This procedure must consider the intrinsic differences of the several approaches used for SFs generation (photocatalysis to photoelectrochemical systems, etc.) and all the physicochemical quantities that can influence and affect the resulting performances (such as temperature, pressure, pH of the electrolyte, etc.). It should also be noted that introducing this habit worldwide would benefit research teams, stakeholders, and investing institutions as they can identify the most promising products among the huge plethora of possibilities. The same considerations also hold for the case of fundamental scientific research, as it is too common to find incomplete results. Even on the definition of the devices, there are significant inhomogeneities.

3. Creating the project portfolio

3.1 Scouting the projects on SFs

Based on the activities discussed in section 2, the first activity was to organise an online meeting between Suner-C/WP2, EIC and projects on SFs part of their project portfolio because the analysis of the results in Table 5 indicates the predominant low TRL of the activities in the area of SFs, and that EIC financed several of them.

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The first Suner-C – EIC project portfolio meeting was organised remotely on 21.06.2022. WP2 (co)-leaders introduced Suner-C. 25 projects of potential interest were identified. Seventeen persons attended the online meeting with the participation of the following projects: FuturoLEAF, NANO-EH, Pulse-Com, NATHALIE, Boostcrop, Artibled, Light-Cap, A-LEAF. Main discussion topics:

- How can projects be motivated to collaborate with Suner-C?
- It is more difficult to find and have links for national projects. What kind of mechanisms can be developed?

Suggestions from the participants:

- The project portfolio should be presented as a database on the Suner-C website. This will facilitate better communication between the projects and will increase their visibility. They already make project clusters; this can be extended to Suner-C, which can act as a supercluster initiative.
- General info and numerical data, e.g., KPIs, can be shown. Here, standardisation (common metrics) comes into the picture. It would be useful to show Suner-C KPIs so they can add them. Otherwise, results cannot be well comparable.
- These KPIs are useful for WP3 for the preparation of the roadmap.
- It is necessary to show the benefits of collaboration with Suner-C. Better positioning their topics in the Suner-C roadmap, future initiative etc).
- Suner-C could use the industrial club to invite other EU projects. This aspect will be an attractive approach since they will hear about Suner-C from industry partners.
- A Suner-C ambassador could be created. All partners, especially industrial partners, should act as ambassadors of Suner-C in social media.
- It is necessary to attract international partners (e.g. Japan sees the EU in the frontline and is ready to invest)
- It would be useful to ask for help from the commission and get some motivation from their side.
- There are strong national activities (e.g. German national H2). It is necessary to contact them.
- EU projects deliver demonstrators (also pilots), created by public funding and dismounted after the project is completed. Create a place and provide the facility for the next projects.
- The projects which are not funded (calls supported by Suner-C) can also be useful. It is necessary to find a mechanism to obtain info about them.

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These suggestions provide useful indications to proceed further in D2.1 activities.

3.2 The first WP2 workshop (online) of the portfolio of projects on SFs

Based on the discussion in this meeting, the further activities to refine to create the project portfolio on SFs were the following:

- Prepare a brief document presenting the motivations to participate in a Suner-C portfolio of projects on SFs
- Contact the projects reported in Table 5 to ask about their interest and willingness to participate or to provide feedback on this activity.
- With the help of the Suner-C board, partners, and the Advocacy group, identify further projects to be contacted.
- Organise a first meeting among the WP Leaders, other members of Suner-C and the projects which positively replied.

Among the motivations for projects to collaborate (voluntarily) with SUNER-C and create a project portfolio, the following aspects were identified:

- better positioning their topic and results in the frame of the initiative (roadmap, future large initiative, etc.)
- enhance the synergies with other projects, and boost their results
- promote dissemination and exploitability of the results of their project
- create new ideas and collaborations with an open forum and discussion (brainstorm-type) platform

The EU CSA SUNER-C (WP2) online workshop was held on June 16th 2023. The following projects (and companies) participated in the workshop:

1. SUSTEPS
2. SUNCOCHEM
3. EPOCH
4. CONDOR
5. SPOTLIGHT
6. ALLGAS CIAN2BIO
7. Photo2Fuel
8. Hydrogenious

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9. Photanol BV
10. ELOBIO, EIC Pathfinder Challenge
11. REALM, EU IA
12. NanoPEC
13. GH2
14. DECADE
15. FUTUROLEAF

An introduction to Suner-C was made, followed by a short presentation (5 min) of each project and a discussion on the benefits of projects to collaborate with SUNER C (WP2). Points discussed were

- how to maximise the path to solar fuels
- how to maximise the impact
    - Boost and extend the impact by sharing (non-confidential) knowledge
    - Create new opportunities and synergies to use knowledge to develop innovative projects
    - Extend interactions out of the specific project or project portfolio.
    - Foster a larger impact by boosting all the area, creating a larger interest group (stakeholder) which defines its strategies and attracts new R&D funds,
    - Create a critical mass to boost the topic and create new project opportunities.
    - Develop common KPIs and metrics to allow better and shared comparison of project results.
- What is required
    - Create trust between researchers/projects to work together to enhance overall impact → Brainstorm meetings (different from the usual scientific ones) where it is possible to conceptually explore new possibilities and identify collaborations to address the common challenges and boost the development of fundamental knowledge necessary
    - Identify the (non-confidential) areas where collaboration among projects/stakeholders is possible, boost research interest of companies
    - Identify opportunities from creating research infrastructures to training networks to any other creative action which can promote R&D and lead to innovation

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3.3 Criteria for the definition of the list of projects on SFs for the WP2 project portfolio

Based on the results described before, the projects selected for the WP2 project portfolio were based on (i) the search of the projects on the topic of solar fuels and then (ii) by validating them from both analyses of the public information available on the projects and feedback they given on the interest to participate to SUNER-C. The list was then discussed during the WP2 meetings to identify possible missing projects.

3.4 The updated list of projects on SFs for the WP2 project portfolio

Based on the results of this first meeting of the portfolio of projects on SFs and further scouting activities involving WP2 partners, SUNER-C board and the projects indicated in the above list, an updated list of projects on SFs for the WP2 project portfolio was prepared and shared among the CSA. Specific attention was given to the EU calls falling into the core objectives of SUNER-C. Based on this list, an electronic database to create a searchable app (to be available on the Suner-C website) is in preparation.

Table 6 reports the updated list (September 5th, 2023) of projects on SFs for the WP2 project portfolio.

This list will be continuously updated to include new projects.

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Table 6 - Updated list (Oct, 2023) of projects on SFs for the WP2 project portfolio.

Table 6A. EIC Solar Energy Conversion portfolio

Coordinator organisation	City, Country	Proj. ID	ACRONYM	Proj title	Web	Total cost (€)	EU Contribution (€)	Start date	End date	Topic(s)	TRL
Teknologian tutkimuskeskus VTT Oy	Espoo, FI	899576	**FuturoLEAF**	Leaf-inspired nanocellulose frameworks for next generation photosynthetic cell factories	https://futuroleaf.com/	2.949.433	946.856	01/09/2020	31/08/2023	H2020-FETOPEN-2018-2020	3
Fundacio privada institut catala d'investigacio quimica	Tarragona, ES	951843	**LICROX**	Light assisted solar fuel production by artificial CO2 Reduction and water Oxidation	https://licrox.eu/	3.199.603	631.938	01/09/2020	31/08/2023	H2020-FETPROACT-2019-2020	3-5
Fundacion imdea energia	Mostoles Madrid,ES	101017928	**HYSOLCHEM**	A Hybrid Reactor for Solar CO2 and N2 Conversion Coupled to WasteWater Treatment	https://www.hysolchem.eu/	2.762.533	801.875	01/01/2021	31/12/2023	H2020-FETPROACT-2018-2020	3-5
University of Uppsala	Uppsala, SE	828838	**SoFiA**	Soap Film based Artificial Photosynthesis	http://sofiaproject.eu/	3.205.280	700.563	01/01/2019	30/06/2023	H2020-FETOPEN-2018-2020	<3
Unibertsitatea del pais vasco/ euskal herriko unibertsitatea	Leioa, ES	101046836	**CATART**	Reaction robot with intimate photocatalytic and separation functions in a 3-D network driven by artificial intelligence	https://catartproject.eu	2.871.775	672.500	01/09/2022	31/08/2026	HORIZON-EIC-2021-PATHFINDEROPEN-01	<3
ENGIE	Courbevoie. FR	838014	**C2FUEL**	Carbon Captured Fuel and Energy Carriers for an Intensified Steel Off-Gases based Electricity Generation in a Smarter Industrial Ecosystem	https://c2fuel-project.eu/	4.130 .291	3.999.840	01/07/19	30/11/23	H2020-LC-SC3-2018-2019-2020	>5
Fundacio privada institut catala d'investigacio quimica	Tarragona, ES	732840	**A-LEAF**	An Artificial Leaf: a photo electro-catalytic cell from earth-abundant materials for sustainable solar production of CO2-based chemicals and fuels	http://www.a-leaf.eu	7.980.861	879.713	01/01/2017	30/06/2021	H2020-FETPROACT-2016-2017	<3

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Julius-maximilians-universitat wurzburg	Würzburg, GE	665085	**DIACAT**	Diamond materials for the photocatalytic conversion of CO2 to fine chemicals and fuels using visible light	https://www.diacat.eu/	3.872.982	615.125	01/07/2015	01/12/2019	H2020-FETOPEN-2014-2015	<3
Linkopings universitet	Linköping, SE	800926	**Hyphoe**	Hybrid Electronics based on Photosynthetic Organisms	Https://hyphoe.eu/	3.311.110	1.073.7030	01/09/2018	31/10/2021	H2020-FETOPEN-1-2016-2017	<3

(**Colour codes** - Green: Ongoing Project; Orange: Ended Project; Blue: Associated Project)

Table 6B. EIC Pathfinder Green Hydrogen Challenge portfolio

Coordinator organisation	**City, Country**	**Proj. ID**	**ACRONYM**	**Proj title**	**Web**	**Total EU Contribution (€)**	**EU Contribution (€)**	**Start date**	**End date**	**Topic(s)**	**TRL**
Acondicionamiento tarrasense associacion (Leitat)	Barcelona, ES	101070721 Cofunded by Innovate UK	**GH2**	GreenH2 production from water and bioalcohols by full solar spectrum in a flow reactor	https://www.gh2-project.eu/about	2.201.655	448.138	01/10/2022	30/09/2025	HORIZON-EIC-2021-PATHFINDERCHALLENGES-01	3-5
Universitat jaume i de castellon	Castellon de la plana, ES	101071010	**OHPERA**	Optimised Halide Perovskite nanocrystalline based Electrolyser for clean, robust, efficient and decentralised pRoduction of H2	https://ohpera.eu/project/	3.229.932	695.324	01/10/2022	31/03/2026	HORIZON-EIC-2021-PATHFINDERCHALLENGES-01	<3
Agencia estatal consejo superior de investigaciones cientificas	Madrid, ES	101070948	**PhotoSynH2**	Photosynthetic electron focusing technology for direct efficient biohydrogen production from solar energy	https://photosynh2.org	4.194.948	1.175.698	01/10/2022	30/09/2027	HORIZON-EIC-2021-PATHFINDERCHALLENGES-01	3-5
Eden tech	Paris, FR	101069981	**MacGhyver**	Microfluidic wAstewater treatment and Creation of Green HYdrogen Via Electrochemical Reactions	https://greenhydrogen-pathfinder.eu	3.644.380	1.169.448	01/09/2022	31/08/2026	HORIZON-EIC-2021-PATHFINDERCHALLENGES-01	4

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Politecnico di torino	Torino, IT	101070741	**H2STEEL**	Green H2 and circular bio-coal from biowaste for cost-competitive sustainable Steel	https://h2steelproject.eu	2.368.910	824.375	01/10/2022	30/09/2025	HORIZON-EIC-2021-PATHFINDERCHALLENGES-01	3
Lulea tekniska universitet	Lulea, SE	101070976	**EPOCH**	Electrocatalytic Production of liquid Organic hydrogen carrier and CHemicals from lignin	https://www.ltu.se/research/subjects/Energiteknik/Forskningsomraden/Forskningsomrade-4/EPOCH/Om-EPOCH?l=en	3.502.968	739.143	01/10/2022	30/09/2026	HORIZON-EIC-2021-PATHFINDERCHALLENGES-01	4
National University of Ireland Galway	Galway, IR	101071111	**ANEMEL**	A Nion Exchange Membrane Electrolysis from Low-grade water sources	https://cordis.europa.eu/project/id/101071111 & www.nuigalway.ie/chemlight.	2.960.236	820.191	01/09/2022	31/08/2026	HORIZON-EIC-2021-PATHFINDERCHALLENGES-01	3-5
University of Turku	Turku, FI	101070788	**DualFlow**	Dual circuit flow battery for hydrogen and value-added chemical production	https://cordis.europa.eu/project/id/101070788	2.835.283	605.350	01/10/2022	30/09/2026	HORIZON-EIC-2021-PATHFINDERCHALLENGES-01	<3
CNRS	Lyon, FR	101070856	**ELOBIO**	ELectrOlysis of BIOmass	https://elobio.cnrs.fr	3.998.000		01/01/2023	31/12/2026	HORIZON-EIC-2021-PATHFINDERCHALLENGES-01	4

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Table 6C. Other HE/H2020 projects (*Sunergy supported project)

Coordinator organisation	City, Country	Proj. ID	ACRONYM	Proj title	Web	Total EU Contribution (€)	EU Contribution (€)	Start date	End date	Topic(s)	TRL
European Research Institute of Catalysis A.I.S.B.L.	Bruxelles, BE	862030	**DECADE**	DistributEd Chemicals And fuels production from CO2 in photoelectrocatalytic DEvices	https://www.decadeproject.eu/contact/	5.198.757	655.369	01/05/2020	30/04/2024	H2020-NMBP-ST-IND-2019	3-5
IDENER RESEARCH & DEVELOPMENT AGRUPACION DE INTERES ECONOMICO	Sevilla, S	101069357	**Photo2Fuel**	Artificial PHOTOsynthesis to produce FUELs and chemicals: hybrid systems with microorganisms for improved light harvesting and CO2 reduction	https://www.photo2fuel.eu	2 493 171	678 750	01/09/2022	31/08/2025	HORIZON-CL5-2021-D2-01	4
University of Bologna	Bologna, Italy	101006839	**CONDOR**	COmbined suN-Driven Oxidation and CO2 Reduction for renewable energy storage	https://condor-h2020.eu	3 989 116	854 250	01/11/2020	21/10/2024	H2020-LC-SC3-2018-2019-2020	<3
Toyota motor Europe nv	Brussel, BE	883264	**Sun-To-X**	Solar Energy for Carbon-Free Liquid Fuel	https://sun-to-x.eu	5.198.757	233.883	01/09/2020	29/02/2024	H2020-LC-SC3-2019-NZE-RES-CC	3-5
Fundacio eurecat	Cerdanyola del valles(Barcelona), ES	862192	**SunCoChem**	Photoelectrocatalytic device for SUN-driven CO2 conversion into green CHEMicals	https://suncochem.eu	6.617.645	1.018.783	01/05/2020	30/04/2024	H2020-NMBP-ST-IND-2019	3-5
Technische Universitaet Wien	Wien, AT	864991	**CARBOFLOW**	Streamlined carbon dioxide conversion in ionic liquids â€ "a platform strategy for modern carbonylation chemistry	https://www.ias.tuwien.ac.at/ks/research-topics/carbon-dioxide-valorization	1.963.515	1.963.515	01/01/2021	31/12/2025	ERC-2019-COG	<3

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Universita degli studi di messina	Messina, IT	810182	**SCOPE**	Surface-COnfined fast-modulated Plasma for process and Energy intensification in small molecules conversion	http://ww2new.unime.it/scope/index.php	9.979.269	2.491.413	01/04/2019	31/03/2025	ERC-2018-SyG	<3
Acondicionamiento tarrasense associacion	Terrassa, ES	101022202	**NEFERTITI**	Innovative photocatalysts integrated in flow photoreactor systems for direct CO2 and H2O conversion into solar fuels	https://projectnefertiti.eu	3.844.428	981.846	01/07/2021	30/06/2025	H2020-LC-SC3-2020-NZE-RES-CC	3-5
Universitat politecnica de valencia	Valencia, ES	101022649	**METHASOL**	International cooperation for selective conversion of CO2 into METHAnol under SOLar light	https://methasol.eu	3.999.634	708.020	01/07/2021	31/12/2024	H2020-LC-SC3-2020-NZE-RES-CC	3-5
Nederlandse organisatie voor toegepast natuurwetenschappelijk onderzoek tno	Den haag, NL	101015960	**SPOTLIGHT**	Disruptive photonic devices for highly efficient, sunlight-fueled chemical processes	https://spotlight-project.eu	5.604.959	911.719	01/01/2021	31/12/2023	H2020-ICT-2018-20	3-5
Helmholtz-Zentrum Berlin für Materialien und Energie, Germany	Berlin, GE	804092	**ME4OER**	Mechanism Engineering of the Oxygen Evolution Reaction	https://www.helmholtz-berlin.de/forschung/oe/ce/oxygen-evolution/index_en.html	1.499.980	1.499.980	01/03/2019	29/02/2024	ERC-2018-STG	<3
Ludwig-maximiilians universitaet Muenchen	Muenchen, GE	854126	**PhotoRedesign**	Redesigning the Photosynthetic Light Reactions	https://doi.org/10.1111/tpj.15552	7496 829	2 499 900	01/04/2022	31/03/2026	ERC-2019-SyG	<3

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University of Applied Sciences	Freising,GE	101045008	**E-VOLUTION**	Electrifiying peptide synthesis for directed evolution of artificial enzymes	https://ebt.cs.tum.de/en/e-volution-erc-consolidator-grant/?lang=en	1 997 993		01/09/2022	31/08/2027	ERC Consolidator Project	<3
COMET GLOBAL INNOVATION, SL	Barselona, Spain	101069359	**SolDAC**	Full spectrum SOLar Direct Air Capture & conversion	https://soldac-project.eu	2 073 781	451 500	01/09/2022	31/08/2025	HORIZON-CL5-2021-D2-01	4
Scientific and Technological Research Council of Türkiye - Marmara Research Center (TUBITAK-MAM)	Istanbul, TR		**SUSTEPS**	Sustainable, Secure and Competitive Energy through Scaling Up		2.999.536		2023		HORIZON-CL5-2022-D3-03	<3
Necton-companhıa portuguesa de culturas marınhas sa	Faro,PRTGL	101060991	**Realm**	Reusing effluents from agriculture to unlock the potential of microalgae	Https://realmalgae.eu/	10.229.318	1.993.950	01/07/2022	31/06/2026	horızon-cl6-2021-cırcbıo-01	6
FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG EV	Munich, DE	101122061	**SUNGATE***	SUnlight-driven Next Generation Artificial photosynthesis bio-hybrid TEchnology platform for highly efficient carbon neutral production of solar fuels		4 897 007,05	1 826 558,56	01/10/2023	30/09/2027	HORIZON-CL5-2022-D3-03	5
UNIVERSITETET I OSLO	Oslo, NO	101122323	**REFINE**	From solar energy to fuel: A holistic artificial photosynthesis platform for the production of viable solar fuels		3 925 221,48	1 132 814,01	01/11/2023	31/10/2027	HORIZON-CL5-2022-D3-03	3

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VLAAMSE INSTELLING VOOR TECHNOLOGISCH ONDERZOEK N.V.	Mol, BE	101091715	**FIREFLY**	FlexIble, predictive and Renewable Electricity powered electrochemical toolbox For a sustainable transition of the catalyst-based European chemicaL industrY	https://www.firefly-project.eu/	11 078 742,50	3 163 176,00	1/1/2023	31/12/2026	HORIZON-CL4-2022-TWIN-TRANSITION-01	4-6
SINTEF AS	Trondheim, NO	101091554	**HYPER**	An electrochemically produced oxidiser for modular, onsite generation of HYdrogen PERoxide	https://www.hyperhorizon.eu/	7 254 450,00	1 054 513,75	1/1/2023	31/12/2026	HORIZON-CL4-2022-TWIN-TRANSITION-01	3-5
FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG EV	Munich, DE	101091934	**Power2Hype**	Electrochemical synthesis of hydrogen peroxide from water, air and renewable electric energy	https://www.power2hype.eu/	10 173 341,25	1 256 727,50	1/1/2023	31/12/2026	HORIZON-CL4-2022-TWIN-TRANSITION-01	5-6
Fundacion IMDEA Energia	Madrid, ES	101084336	**BIOCTANE**	Synergetic integration of BIOteChnology and thermochemical CaTalysis for the cAscade coNvErsion of organic waste to jet-fuel	https://www.bioctane.eu/	2 951 957,50	594 273,75	01/11/2022	31/10/2026	HORIZON-CL5-2021-D3-03	5-6
FRIEDRICH-ALEXANDER-UNIVERSITAET ERLANGEN-NUERNBERG	Erlangen, DE	101084336	**CarbonNeutralLNG**	Truly Carbon Neutral electricity enhanced Synthesis of Liquefied Natural Gas (LNG) from biomass	https://www.carbonneutrallng.eu/	3 306 160,00	709 062,50	01/11/2022	31/08/2026	HORIZON-CL5-2021-D3-03	5-6
AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	Madrid, ES	101083700	**E-TANDEM**	HYBRID TANDEM CATALYTIC CONVERSION PROCESS TOWARDS HIGHER OXYGENATE E-FUELS	https://e-tandem.eu/	3 334 885,00	587 378,75	01/11/2022	30/04/2026	HORIZON-CL5-2021-D3-03	4

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UNIVERSITEIT GENT	Gent, BE	101058100	**e-CODUCT**	Fast-response Electrically heated catalytic reactor technology for CO2 reDUCTion	https://e-coduct.eu/	7 022 265,00	1 225 625,00	01/09/2022	31/08/2025	HORIZON-CL4-2021-RESILIENCE-01	6-9
SINTEF AS	Tronheim, NO	101058293	**eQATOR**	Electrically heated catalytic reforming reactors	https://www.eqator.eu/	7 535 960,38	1 754 390,00	01/06/2022	30/10/2025	HORIZON-CL4-2021-RESILIENCE-01	6
TECHNISCHE UNIVERSITAET MUENCHEN	Munich, DE	101058608	**EReTech**	Electrified Reactor Technology	https://www.eretech.eu/	7 352 357,15	1 563 990,00	01/06/2022	30/10/2025	HORIZON-CL4-2021-RESILIENCE-01	6-7
AALTO KORKEAKOULUSAATIO SR	Espoo, FI	101118239	**CIRCULAR FUELS**	Production of sustainable aviation fuels from waste biomass by coupling of fast pyrolysis with solar energy	https://circularfuels.eu/	4 997 353,50	754 857,50	01/07/2023	30/06/2027	HORIZON-CL5-2022-D3-02	6-7
UNIVERSITY COLLEGE CORK - NATIONAL UNIVERSITY OF IRELAND, CORK	Cork, IR	101084261	**FreeHydroCells***	Freestanding energy-to-Hydrogen fuel by water splitting using Earth-abundant materials in a novel, eco-friendly, sustainable and scalable photoelectrochemical Cell system	https://freehydrocells.eu/	3 748 300,00	1 510 442,50	01/10/2022	28/02/2026	HORIZON-CL5-2021-D3-03-03	4-5
AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	Madrid, ES	101007006	**PRODIGIO**	Developing early-warning systems for improved microalgae PROduction and anaerobic DIGestIOn	https://prodigio-project.eu/	2 452 941,25	583 750,00	01/01/2021	31/12/2023	H2020-LC-SC3-2018-2019-2020	5-7
INSTITUT MINES-TELECOM	Palaiseau, FR	101122101	**COCPIT**	sCalable solutions Optimisation and decision tool Creation for low impact SAF Production		4 999 497,23	999 375,00	01/10/2023	30/09/2027	HORIZON-CL5-2022-D3-03	5-7

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				chain from a lIpid-rich microalgae sTrain							
AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	Madrid, ES	101122151	**FuelGae**	Sustainable On-site and Innovative Technologies for Advanced Transport BioFuels from MıcroalGae	4 990 123,81	849,947.00	01/10/2023	30/09/2027	HORIZON-CL5-2022-D3-03	5-7
BAUHAUS LUFTFAHRT EV	Taufkirchen - Munich, DE	101122206	**SUN-to-LIQUID II**	SUNlight-to-LIQUID - Efficient solar thermochemical synthesis of liquid hydrocarbon fuels using tailored porous-structured materials and heat recuperation	4 880 120,40	826 952,20	01/11/2023	31/10/2027	HORIZON-CL5-2022-D3-03	4-6
IDENER RESEARCH & DEVELOPMENT AGRUPACION DE INTERES ECONOMICO	Seville, ES	101118129	**PHOTOSINT**	PHOTOelectrocatalytic systems for Solar fuels energy INTegration into the industry with local resources	4 993 752,50	754 375,00	01/09/2023	31/08/2027	HORIZON-CL5-2022-D3-02-06	4-6

Climate, Energy and Mobility

CONSORZIO INTERUNIVERSITARIO NAZIONALE PER LA REATTIVITA CHIMICA E LA CATALISI - CIRCC	BARI, IT	101083355	**DESIRED**	A novel flow reactor utilising recyclable hybrid electrocatalysts to produce CH_3OH and C2+ solar fuels also usable as precursors of sustainable aviation fuels	https://desired-project.eu/	3 058 752	3 058 752	01/11/2022	31/10/2026	HORIZON-CL5-2021-D3-03-02	3-5

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Projects Solar-driven Chemistry network (network of European research-funding organisations): SUNCOCAT (coordinated by Solar Fuels Laboratory, CeNT UW, University of Warsaw, Poland (Joanna Kargul);

UW Centre of New Technologies	Warsow, PL	ERA-NET (DFG)	**SUNCOCAT**	Rational design of efficient energy and charge transfer in biophotoelectrodes for direct conversion of CO2 into fuel	https://en.uw.edu.pl/cents-research-on-solar-energy-and-carbon-dioxide/	about 1.2M€	2023	2026	3-4

Table 6D. National large projects: SynBio Labs Finland

	Finland	?	**SynBio Power Labs**	Accelerate advanced biotechnology and synthetic biology innovations by building the biggest pilot-scale facility for precision fermentation in Finland	https://www.synbiopowerlabs.com	7 000 000 €	2023		6-7
Fraunhofer CSP	Germany	funded by German Federal Ministry for Economic Affairs and Climate Action	**NanoPEC**	NanoPEC - Efficient, stable and application-ready reactors for photoelectrochemical water splitting based on nanostructured absorbers			2023	2026	5-7

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3.5 The second WP2 workshop of the portfolio of projects on SFs

The second WP2 workshop for the project portfolio on SFs was organised by the Suner-C WP2 co-leaders on October 10th, 2023, to enable in-person meetings for the projects interested in participating while providing the option of electronic connection to facilitate participation. The meeting took place in Brussels before the Midterm meeting of the Suner-C project. Workshop participants also had the opportunity to join the General Assembly and the Stakeholder Dialogue meeting.

19 persons, 4 remote, participated in the meeting, with a very active discussion. The following questions were asked of participating projects to be presented and discussed during this meeting:

1. What would be the specific contribution, in terms of R&D&I, that your project could bring to the general objectives?
2. 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.
3. Is there specific (non-confidential) knowledge that your project could share with the others to reach the above objectives? Please differentiate in terms of materials, electrodes, reactors, etc.
4. Can you identify R&D areas where accelerating knowledge sharing would be necessary for increasing the impact of your project?
5. 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?
6. 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?

Many valuable comments were made both regarding aspects that should be emphatized in definying the paths to accelerate the introduction of solar fuels, and in terms of KPI, that should be defined in a wider perspective than those used currently, such as solar-to-fuel efficiency.

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3.6 A database of EU projects

A large database of EU projects has been created. Details are in the Annex 1. It is available for use inside the project, while external access will be made when will be solved the aspects of confidentiality.

4. Conclusion

This document presents the consortium strategy and actions to create a portfolio of projects on SFs, and it identifies the relevant project objectives, tools, actions and overall strategies. This portfolio of projects, the objective of Task 2.1, was and will be used to achieve the objectives of the other tasks in WP2 (Tasks 2.2-2.4), and the first activities in this direction were reported.

This project portfolio on SFs will be updated and adapted depending on the progress and evolution of the project and incorporating the feedback of the community and project office.

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