SUNER-C: SUNERGY Community and eco-system for accelerating the development of solar fuels and chemicals

DELIVERABLE 1.2

DRAFT OF COMMUNITY MAPPING & ECOSYSTEM

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	01/06/2022
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

Table 2

Management Information	
Version 0.1	17 November 2023
WP	1 – Creation of a R&I community and eco-system
Lead and co-lead beneficiaries	Leiden University and Uppsala University
Dissemination Level	Public
Authors	CO_2 Value Europe (CVE)
Deliverable Number	D1.2
Deliverable Name	Draft of community mapping & ecosystem
Reviewers	LU, UppU & Project Coordination Team (UU, CEA & ICIQ)
Abstract	This deliverable explains how the SUNER-C consortium has started to provide an online platform allowing users to search and locate on a map, institutions and initiatives active in specific competencies and related to the development of solar fuels and chemicals.

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Table 3

Document History				
Version	**Due Date**	**Responsible**	**Action**	**Status**
Draft 1	6 November 2023	Laura Lopez (ICIQ)	Internal review of draft version 1 finalised	Draft
Draft 2	17 November 2023	Anastasios Perimenis & Lili Chatzikonstantinou & (CVE)	Internal review of draft version 2 finalised	Draft
Draft 3	21 November 2022	Huub De Groot (LU) & Ann Magnuson (UppU)	Draft version 2 circulated to WP1 leaders and received their feedback **by 26 November 2023**	Draft
Draft 4	30 November 2022	Lili Chatzikonstantinou (CVE)	Implement final feedback and submit the deliverable	Final version

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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) 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, D1.2 Draft of community mapping and ecosystem, is a deliverable of the SUNER-C project, which is funded by the European Union's Horizon Europe under Grant Agreement No 101058481.

The main aim of the document is to provide a description of the first version of the mapping exercise that has started during the first half of the project and will be continued through the second half, to provide a final populated version of an online platform allowing users to search and locate on a map, institutions, and initiatives active in specific competencies related to the development of solar fuels and chemicals.

A full description of the target groups to be included in the mapping exercise, as well as the key competencies, divided into three different layers is provided. As well as a first version of the online tool, currently available with a first selection of data provided by the SUNER-C consortium.

Finally, the document also includes a description of the next steps to be followed to finish up with a large populated mapping tool.

Table of Contents

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List of abbreviations

List of abbreviations	
CSA	Coordination and Support Actions
C&D	Communication and Dissemination
D	Deliverable
H2020	Horizon 2020
IAB	International Advisory Board
IEA	International Energy Agency
KPIs	Key Performance Indicators
LSRI	Large-Scale Research and Innovation Initiative
MI	Mission Innovation
NGOs	Non-Governmental Organisations
RTOs	Research and Technology Organisations
R&D	Research and Development
R&I	Research and Innovation
SMEs	Small and Medium-Sized Enterprises
SRIA	Strategic Research and Innovation Agenda
WP	Work Package

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1 Definition of groups and competencies

1.1. Main objective of the community mapping exercise

The task of the community mapping has as its main objective 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, in a large-scale R&I initiative on solar fuels and chemicals.

This includes all sectors of society such as academia, industry, SMEs, local/regional/national governments, NGOs, and policymakers as well as other European LSRIs (e.g., partnerships, missions).

Data mining will result in a searchable online database for unconstrained community mapping to be hosted on the SUNER-C website. The mapping will provide measurements of gender balance and geographical distribution in all parts.

1.2. Definition of Target groups

The definition of Target groups has been done in accordance with the text included in the SUNER-C proposal. Therefore, the target groups to be included in the community mapping platform are the following:

- **Industry**: companies, industry associations (European, e.g., CO_2 Value Europe, the European Chemical Industry Council; national level), SMEs, start-ups, spin-offs;
- **Research/academia**: universities, RTOs, applied research centres, university/research platforms & associations;
- **Financial players/investors**: venture capitalists, business angels;
- **Societal stakeholders**: consumer organisations, environmental organisations, NGOs, trade unions, citizens & consumer organisations, educational platforms/initiatives, student and teacher networks;
- **National platforms and R&I projects/initiatives** including initiatives with which SUNER-C partners are connected to (e.g., CATLAB in Germany; MOONSHOT in Belgium; Missie H2 in The Netherlands; SMARTNESS – Solar- driven chemistry in Italy);
- **EU platforms and partnerships**: Processes4Planet, Clean Energy Transition, Clean Hydrogen, European Cluster on Catalysis, European Raw Materials Alliance;
- **Policy/decision makers** at different levels: local (e.g., municipalities), regional, national (including national governments, funding agencies, unions and cooperative societies, etc.), European (European Commission, European Parliament, Council of the EU);

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- **International organisations and leading international initiatives**: Mission Innovation, International Energy Agency (IEA), the Liquid Sunlight Alliance (US), US Department of Energy, Natural Sciences and Engineering Research Council of Canada, Global CO_2 Initiative, CO_2 Value Australia. **Relevant media**: targeted as channels to reach out to the "general" public.

1.3. Definition of Competencies

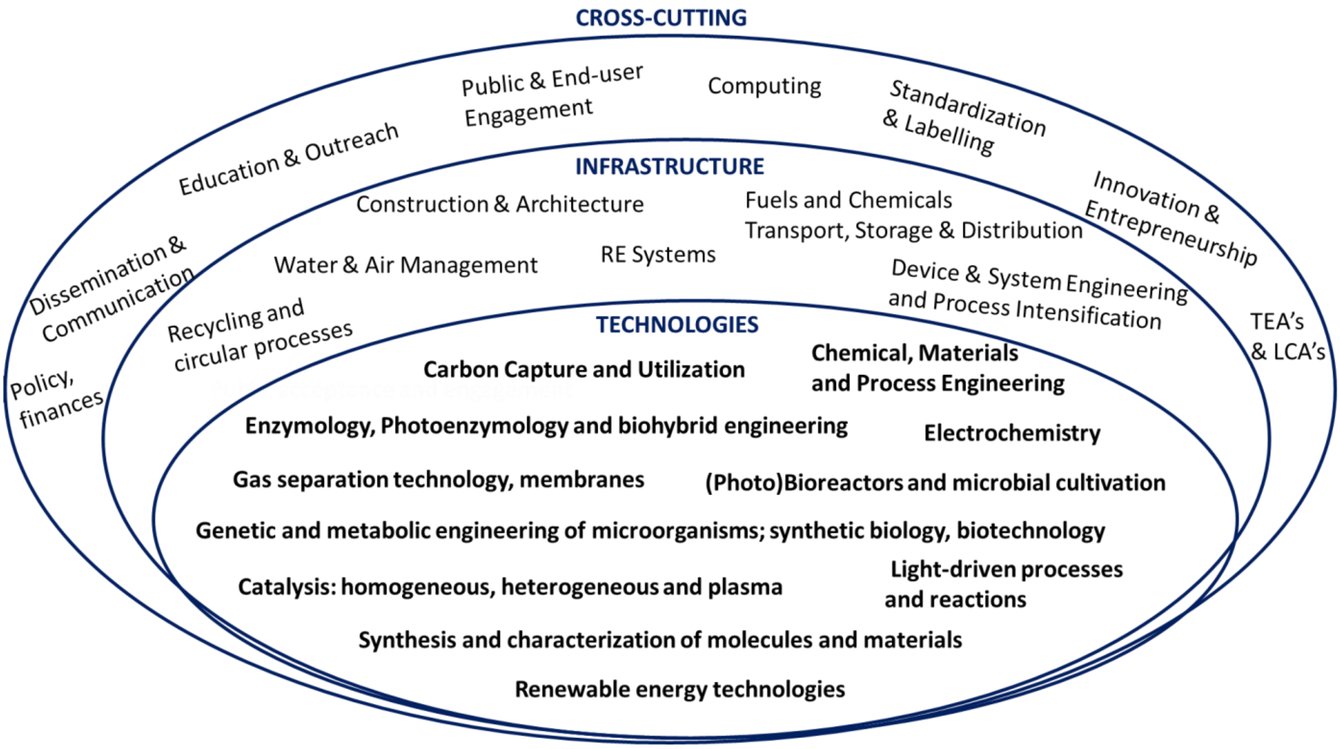

Figure 1. Classification of competencies in three different levels: Technology-related, Infrastructure-related, or Cross-cutting competencies.

The definition of competencies has been done according to the ones already described in the Blueprint document generated within the SUNRISE action,[1] and modified as required, so to include all the different actors within the solar fuels and chemicals value chain. Additionally, the competencies have been divided into three levels, to facilitate their identification and help user searches within the online platform. The following competencies are included in the mapping platform:

[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

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I. Technology-related competencies.

- **Renewable energy technologies**. Current solar energy technologies include photovoltaics, CSP, and solar thermal technologies. Development of technologies for the production of sustainable fuels and chemicals will benefit from synergies with this sector and the wind energy technologies, as well as hydropower and other renewable energy technologies. This includes production, deployment of an operation of systems and components.
- **Carbon Capture and Utilization**. Capture of carbon dioxide from flue gas or ambient air is the first step in the cycle of carbon dioxide conversion to fuels and chemicals. Current prospects for direct air capture would result in large energy losses for the CO_2 capture and concentration. SUNER-C aims to drastically reduce those energy losses by novel concepts. By direct coupling of CO_2 capture to catalysis, optimally matching the CO_2 flow and photocatalytic reactions, thermodynamic losses can be minimized. This requires more research on new concepts. CO_2 capture from point sources, such as industrial emissions, can significantly reduce the carbon footprint of major industrial sectors. The competences of many stakeholders are needed for the transition to a circular and CO_2 neutral economy.
- **Electrochemistry**. Electrochemistry is essential for electrocatalytic fuel formation and for their use in fuel cells. It is needed to guide the design of materials, devices, and systems. Relevant competence is also available in the battery research and industry.
- **Light-driven processes and reactions**. This competence area includes the related but distinct fields of photophysics, photochemistry, natural photosynthesis, photocatalysis, and photoelectrochemistry. They provide fundamental scientific knowledge of electronically excited states, charge separation, and quantum behavior in natural photosynthesis, molecules, microorganisms semiconductors, nanoscale, and mesoporous systems. This is needed for the synthesis and design of molecules, materials, and devices, as well as for advanced characterization by experimental and theoretical methods.
- **Enzymology, photoenzymology and biohybrid engineering**. Nature provides some of the most efficient and sustainable catalyst, *i.e.*, enzymes. Enzymes and enzymatic photoconversion cascades are investigated to replace inert expensive metals such as platinum in electrochemical and PEC systems. Biohybrid technology, where biological molecules are used in e.g., electrocatalytic devices, is a possible route to reduce cost and increase profit for the generation of hydrogen, ammonia, and manufacturing of hydrocarbons by carbon capture and utilization. The critical hurdle for biotic systems is their robustness over time, and scientific and technical understanding of enzymatic reactions and processes are needed to design, evaluate and develop new conversion cascades and perform microengineering of reactors combining biotic with abiotic components that fulfil requirements of performance, durability, and scalability.

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- **Genetic and metabolic engineering of microorganisms; synthetic biology, biotechnology**. Genetic and metabolic approaches are widely used today to re-design microorganisms for the efficient production of targeted solar fuels and chemicals. Synthetic metabolic pathways can be inserted into microorganisms to allow for the production of the fuel or chemical of choice. Biotechnological methods are enablers of this development.
- **Bioprocess Engineering, (Photo)Bioreactors and microbial cultivation**. Bioreactor and photobioreactor competence, and competence in the cultivation of photosynthetic microorganisms, is needed for the design and operation of large-scale production of solar fuels and solar chemicals. The competence is valuable for photoreactor design, also with non-biological approaches.
- **Synthesis and characterization of molecules and materials**. Preparation of materials and components is an obvious need for the development of solar fuels and chemicals.
- **Chemical catalysis: homogeneous, heterogeneous and plasma**. Solar fuels and chemicals from small molecules such as water and carbon dioxide require good catalysts that operate at a high rate and selectivity, to form pure products at minimum energy cost. In this regard, plasma approaches, also including plasma catalysis, which is considered an emerging branch of plasma processing; a highly versatile technique that can provide highly specialized materials such as semiconductors and nanostructures at mild conditions and also several specialty chemicals, should also be considered. Scientific and technical understanding of catalytic reactions and processes are needed to design, evaluate, and develop new catalysts that fulfil requirements of performance, durability, and scalability.
- **Gas separation technologies and membranes.** Advances on these topics are essential as most design concepts for gaseous solar fuel formation include a membrane for the separation of product gases, e.g. hydrogen or syngas from oxygen. At the same time, the membrane should allow for rapid proton transport from the anode to the cathode.
- **Chemical, Materials and Process Engineering.** For the production of components and modules for the SUNER-C technology systems, as well as for the handling of products, engineering is required.

II. Infrastructure-related competencies

- **Renewable Energy systems (RE systems).** When consumers and industries produce and exchange solar fuels and solar chemicals, new energy distribution systems and regulations have to be developed and put into place. To optimally integrate the use of renewables into existing networks, smart grids technology needs to be developed further, supported by information technology, policy regulations, and market instruments.

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- **Construction and Architecture**. Large-scale deployment of solar technologies will need the competence of construction companies. Including new technology starts at the drawing board.
- **Recycling and circular processes**. This includes the activities and actions required to reuse product materials and manage waste streams in a circular manner, including the collection, transport, sorting, re-use, and recycling of waste, supported by circular policy regulations and circular business models.
- **Fuels & Chemicals Transport, Storage and distribution.** This includes handling, storage, and transportation of gaseous and liquid products from solar fuels and chemicals technologies, with different modalities including heavy-duty vehicles, pipelines, and ships. The infrastructure should be adapted for both small-scale production of solar fuels on e.g., house roofs as well as for large-scale production of jet fuels.
- **Device and system engineering and Process Intensification**. Devices, processes, and systems need to be optimized based on lab-scale Proof-of-Concepts to lab-scale demos for making fuel from CO_2 and sunlight on a house roof. In parallel, large-scale Proof-of-Concepts will be obtained for running pilot production of jet fuel and further scale-up at industrial sites. This includes computational design of devices considering e.g., fluid dynamics, heat management, etc. as well as building hardware. Regarding process intensification, this term includes key engineering actions that render a manufacturing or processing design substantially improved in terms of energy efficiency, cost-effectiveness, or enhancement of other qualities. **Downstream processing for separation of product mixes**, the improvement of the purity of the final product(s), could also be included herein, to be accomplished through a series of unit operations used to isolate, purify, and concentrate the product(s).
- **Water and air management**. This is focused on the processes of chemically scrubbing carbon dioxide from industrial exhaust gasses, directly from ambient air, or from seawater. In addition, water is needed for water-splitting reactions of large-scale solar fuels technology, and the quality of water needs to be matched to the technological requirements. To achieve this in an efficient and economically viable manner, expertise is needed in emission detection technologies and the removal of contaminants from exhaust gas flows and the maritime environment.

III. Cross-cutting competencies

- **Environmental and techno-economic analyses**. Analysis of climate and other environmental impacts, as well as sustainability, is vital for the development and implementation of energy technologies. LCA is a standard tool to assess environmental impacts associated with all the stages of the life cycle of a commercial product, process, or service. Life Cycle Energy Assessment (LCEA) is important to estimate the Energy Return on Energy Invested (EROI). For emerging technologies, it is important to develop

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prospective or ex-ante LCA together with techno-economic analyses as well as social aspects such as assessing public acceptance.

- **Computing.** Several approaches are included herein, being applicable to many of the technologies and infrastructure-related competencies. Including: (i) **Multiscale modelling**: Solar fuels devices and systems need to integrate processes occurring on many different time- and length scales, from femtoseconds to days and from the nano- and mesoscale to at least several meters. Substrates and products in liquid and/or gaseous form need to be provided, transported, and collected; electrons and protons need to be transferred, and transported, concentration gradients handled, etc. Multi-scale simulations are vital for the design and analysis on both the device and the systems level, and an engineering theory for the bottom-up design of modular device concepts is urgently needed. (ii) **Informatics, AI**. Bioinformatics is an important tool for understanding biological data. It can be used e.g., in the analysis of gene and protein expression and regulation, or to optimize metabolic pathways. Informatics, machine learning, and Artificial intelligence (AI) will become more important in the near future also for e.g., materials discovery.
- **Legislation, policy, financing, start-up support**. As part of a large-scale research initiative, additional actions need to be implemented such as leveraging research and innovation funding from both the private sector as well as MS/AC investments. At present, EU RTD schemes rarely go beyond the demonstration stage. For subsequent innovation steps, the much higher efficiency of the private sector compared to academia and research institutions is essential to nurture rapid progress. However, ambitious investments need to be financed if they are to be successful, and the supply of the enormous financial resources that are required upfront by the private R&D stakeholders in small-scale financing operations is unrealistic. The only sector of the financial system that has in principle the capacity to finance an energy innovation effort is the global bond market. While this is globally the biggest source of capital, bonds are low yield, low-risk financial instruments. To finance high-risk innovation trajectories with green bonds, the EU and member state governments can implement de-risking mechanisms where the state backs the risk to release the necessary financial resources on the required scale. Therefore, actors that work on providing financing opportunities, supporting start-up companies and efforts, and also institutions providing appropriate legislation and policy actions to uptake sustainable fuels and chemicals are essential.
- **Standardization & Labelling**. Tasks to identify standardized protocols and experiments to promote comparison between results and define common reliable KPIs are key, as well as enable more effective ways for data sharing.
- **Innovation & entrepreneurship**. Capacities to introduce new business models, products, ideas, or services in the market, as well as all the development of risks and responsibilities for bringing new technologies and ideas to market and building a successful business, are crucial to establishing a new energy market with a share for sustainable fuels and chemicals.

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- **Dissemination and communication.** Good communication with stakeholders, the broader scientific community, policymakers, and civil society needs a clear strategy and good coordination among communication and dissemination of related/initiated projects.
- **Education and outreach.** It is important to support a strong outreach and educational plan – also involving interaction with social sciences and humanities – in order to promote the SUNER-C technologies at all levels of the educational system, i.e., all the way from elementary school to universities, as well as to involve the society at large and mass media professionals, in particular.
- **Public & end-user engagement.** New energy technologies need public involvement and acceptance for large-scale implementation. The solar fuels and chemicals technologies imply wide deployment of light harvesting infrastructures and new industrial facilities for the production and distribution of fuels and chemicals, along with the conversion of existing petrochemical facilities. The availability of raw materials for the new processes and facilities also needs to be carefully addressed. An industrial transformation of this size inevitably implies a social and economic impact on a large scale. In case of success, such changes will be strongly beneficial for society, but this is not immediately obvious to citizens! Therefore, a substantial amount of human and financial resources needs to be mobilized to promote scientifically grounded information on the vast industrial transformation. For the deployment of SUNER-C technologies and products, companies that are willing to drive innovation in this area today are key partners (fertilizers, transport sector, chemical sector, etc.).

2 Online mapping platform

A specific website has been designed within the SUNER-C webpage for the Community Mapping (Figure 2).

This new tool allows users to search institutions and initiatives related to specific competencies. It is possible to filter the results depending on one specific competency and also introduce the country. The filtered institutions can be visualized in a map.

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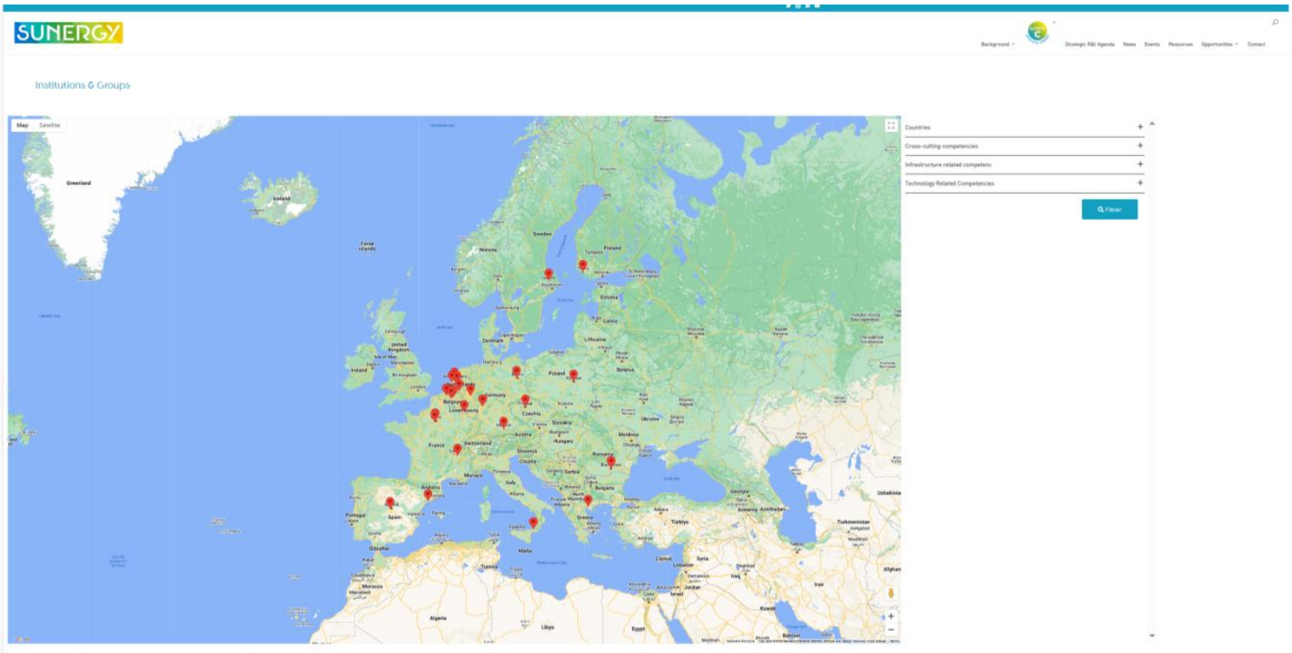

Figure 2. Screenshot of the first Community Mapping site, available through the SUNER-C website.

3 Population of the community mapping

The first version of the community mapping database is populated with the data from the SUNER-C partners, a first search was performed and then each organization was contacted individually using a general questionnaire (Figure 3) for ratification.

This questionnaire will be available within the community mapping site, for spontaneous data introduction (after verification from the project) from interested actors.

Additionally, the site will also contain an interactive module to ask for feedback from users, so to identify any mistakes or missing values.

To populate the community mapping data, the questionnaire will be sent to all SUNERGY supporters, with individual addressed mailing actions and follow-up. Then, other identified actors will also be contacted, and this will serve as a profitable exercise to disseminate the SUNER-C project and the current community, seeking to enlarge it and get new supporters.

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Community Mapping

This exercise is one of the tasks to be performed during the EU-funded project SUNER-C. The main aim is to map stakeholders and initiatives across EU and at national/local levels related to the solar fuels and chemicals value chain. The outcomes will be to provide a searchable database and grow the community reaching new actors from all sectors of society.

* Required

INSTITUTIONAL INFORMATION

1

Name of your organization *

Enter your answer

2

Type of organization

Please select one (here only 1 selection allowed) option from the list below. For a full definition of the Target Groups to be included in the mapping exercise, please check the following website: **https://sunergy-initiative.eu/community-mapping-definitions/** *

- ◯ Industry
- ◯ Research/academia
- ◯ Financial players/investors
- ◯ Societal stakeholders
- ◯ National platforms and R&I projects/initiatives
- ◯ EU platforms and partnerships
- ◯ Policy/decision makers
- ◯ International organisations and leading international initiatives
- ◯ Media

3

Country *

Enter your answer

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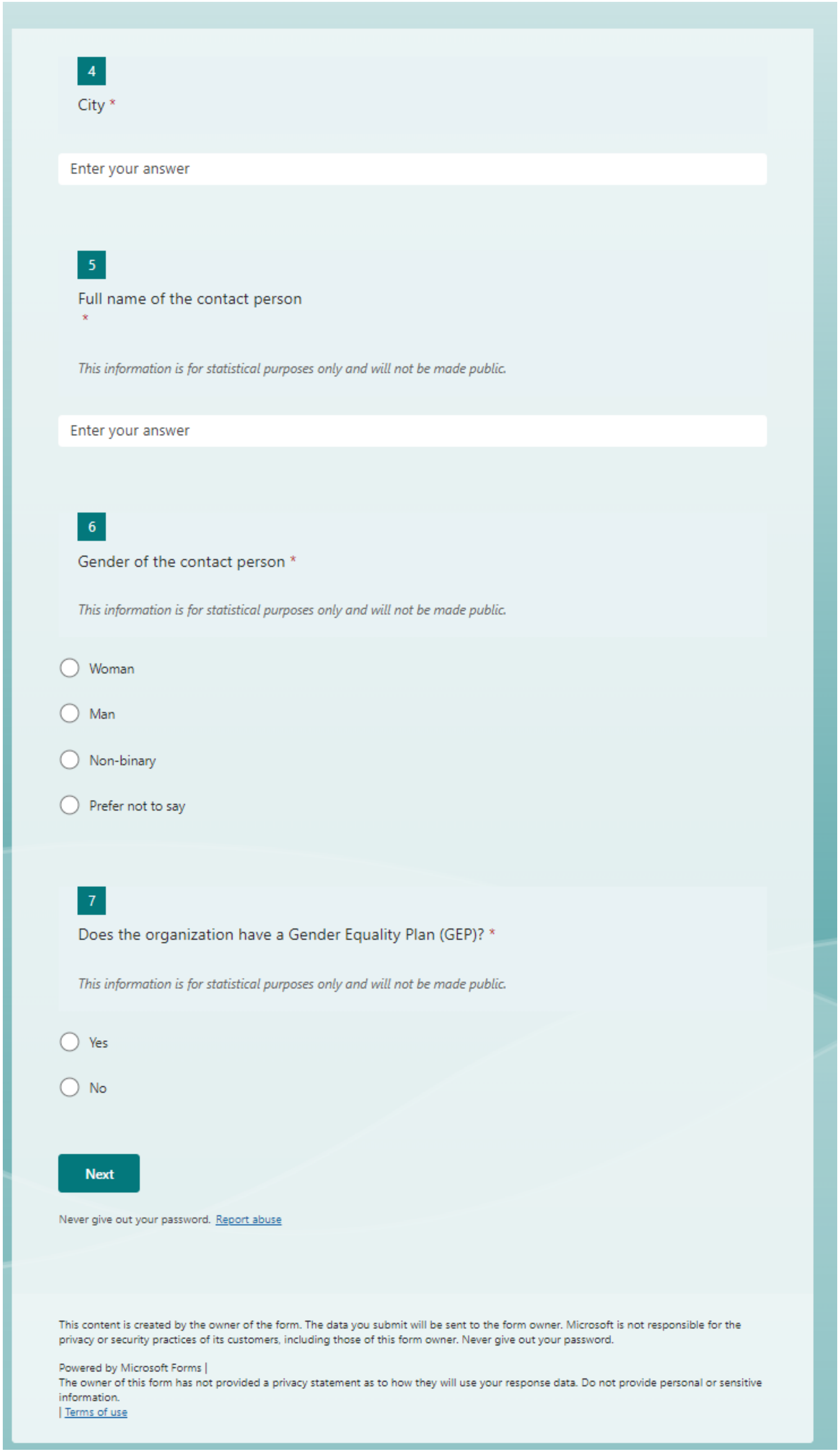

4

City *

Enter your answer

5

Full name of the contact person
*

This information is for statistical purposes only and will not be made public.

Enter your answer

6

Gender of the contact person *

This information is for statistical purposes only and will not be made public.

- Woman
- Man
- Non-binary
- Prefer not to say

7

Does the organization have a Gender Equality Plan (GEP)? *

This information is for statistical purposes only and will not be made public.

- Yes
- No

Next

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MAPPING OF COMPETENCIES

Please select as many options as needed about the different competencies your organization can contribute with. For a definition of the listed competencies, please check the following website: https://sunergy-initiative.eu/community-mapping-definitions/

8

Technology-related competencies *

- ☐ Renewable Energy Technologies
- ☐ Carbon Capture and Utilization
- ☐ Electrochemistry
- ☐ Light-driven processes and reactions
- ☐ Enzymology, Photoenzymology and biohybrid engineering
- ☐ Genetic and metabolic engineering of microorganisms; synthetic biology, biotechnology
- ☐ Bioprocess Engineering, (Photo)Bioreactors and microbial cultivation
- ☐ Synthesis and characterization of molecules and materials
- ☐ Chemical catalysis, homogeneous, heterogeneous and plasma
- ☐ Gas separation technologies and membranes
- ☐ Chemical, Materials and Process Engineering

9

Infrastructure-related competencies *

- ☐ Renewable Energy systems (RE systems)
- ☐ Construction and Architecture
- ☐ Recycling and circular processes
- ☐ Fuels & Chemicals Transport, Storage and distribution
- ☐ Device and system engineering and Process Intensification
- ☐ Water and air management

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10

Cross-cutting competencies *

- [ ] Environmental and techno-economic analyses
- [ ] Computing
- [ ] Legislation, policy, financing, start-up support
- [ ] Standardization & Labelling
- [ ] Innovation & entrepreneurship
- [ ] Dissemination and communication
- [ ] Education and outreach
- [ ] Public & end-user engagement

11

Help us to improve! Is any further information you would like to add? Please share your feedback here.

Enter your answer

Section 3

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12

GDPR: *The processing and collecting of personal data is necessary for the execution of the Community Mapping exercise. SUNER-C/SUNERGY processes personal data in accordance with Regulation (EU) 2018/1725 on the protection of natural persons.*

The full name of the contact person, their gender and the information related to the Gender Equality Plan is only for statistical purposes and will not be made public. *

○ I accept

Figure 3. Screenshots of the questionnaire to be shared with organizations and institutions.

The questionnaire also 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 data will not be made public, just kept for statistical analysis.

Finally, through the questionnaire it is possible to add feedback. This will be important, as the current definition of target groups and competencies, although having been previously assessed within the WP1 participants and at the last consortium meeting, might be susceptible to further changes throughout the project's life.

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